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MCAS EL TORO
SSIC #5090.3

Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway
San Diego, CA 92132-5190

Contract No. N68711-92-D-4670

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

CLEAN II

FINAL
TECHNICAL MEMORANDUM
EVALUATION OF OU-1 ALTERNATIVE 8A WITH RESPECT TO NCP CRITERIA, MARINE CORPS AIR STATION EL TORO, CALIFORNIA

CTO-0161/0349
October 2001

Prepared by:

BECHTEL NATIONAL, INC.
1230 Columbia Street, Suite 400
San Diego, California 92101-8502

Signature: ______________________ Date: 10/17/01
Thurman L. Heironimus, RG 4897, Project Manager

CLEAN II Program
Bechtel Job No. 22214
Contract No. N68711-92-D-4670
File Code: 0227

IN REPLY REFERENCE: CTO-0161/0349

October 18, 2001

Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Mr. Richard Selby, Code 02R1
1220 Pacific Highway
San Diego, CA 92132-5190

Subject: Final Technical Memorandum – Evaluation of OU-1 Alternative 8A With Respect to NCP Criteria – Dated October 2001
MCAS El Toro, CA

Dear Mr. Selby:

It is our pleasure to submit this copy of the Final Technical Memorandum – Evaluation of OU-1 Alternative 8A With Respect to NCP Criteria for the Marine Corps Air Station (MCAS) El Toro, California. This document was prepared under Contract Task Order (CTO) 0161 and Contract No. N68711-92-D-4670 and is submitted in support of the Proposed Plan and Record of Decision for OU-1 and OU-2A. The Technical Memorandum has been revised based on comments submitted by U.S. Environmental Protection Agency, Department of Toxic Substances Control, and Regional Water Quality Control Board, Santa Ana Region and is considered final. The response to comments package is submitted with the Technical Memorandum under separate transmittal.

We appreciate the opportunity to be of service to you on this project. If you have any questions or would like further information, please contact Jane Wilzbach at (619) 744-3029, or myself at (619) 744-3004.

Sincerely,

Thurman L. Heironimus, R.G.
Project Manager

TLH/sp
Enclosure

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BECHTEL NATIONAL INC.

CLEAN II TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N-68711-92-D-4670 **Document Control No.:** CTO-0161/0349

File Code: 0227

TO: Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Mr. Richard Selby, Code 02R1
1220 Pacific Highway
San Diego, CA 92132-5190

DATE: October 18, 2001
CTO #: 161
LOCATION: MCAS El Toro

FROM: Thurman L. Heironimus, Project Manager

DESCRIPTION: Final Technical Memorandum – Evaluation of OU-1 Alternative 8A With Respect to NCP Criteria – Dated October 2001

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10/18/2001, 10:29 AM, sp l:\cleanii\cto\eltoro\cto161\transmittal\tr_final_ncp_memo.doc

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ATTACHMENT

Attachment

FIGURES

TABLES

ACRONYMS/ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
BNI	Bechtel National, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOJ	Department of Justice
DON	Department of the Navy
gpm	gallons per minute
IAFS	interim-action feasibility study
IDP	Irvine Desalter Project
IRWD	Irvine Ranch Water District
JEG	Jacobs Engineering Group Inc.
µg/L	micrograms per liter
MCAS	Marine Corps Air Station
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
OCWD	Orange County Water District
OU	operable unit
PW	present worth
RBC	risk-based concentration
RG	registered geologist
ROD	record of decision
SCAQMD	South Coast Air Quality Management District
SGU	shallow groundwater unit
TCE	trichloroethene
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound

Technical Memorandum

EVALUATION OF OU-1 ALTERNATIVE 8A WITH RESPECT TO NCP CRITERIA, MCAS EL TORO

This technical memorandum describes Alternative 8A, a new alternative that was developed to remediate regional groundwater volatile organic compound (VOC) contamination at Marine Corps Air Station (MCAS) El Toro Operable Unit (OU)-1 Site 18. This memorandum also assesses how Alternative 8A meets each of nine evaluation criteria identified under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Part 300.430(e)(9)(iii) and compares it to six other alternatives evaluated previously in the MCAS El Toro OU-1 Interim Action Feasibility Study (IAFS) Addendum (JEG 1996a). This evaluation is not intended to be a stand-alone document and should be reviewed in conjunction with the IAFS Addendum and the Alternative 8A modeling report that is attached to this memorandum.

Remedial alternatives for Site 18 were developed to meet the following remedial action objectives.

- Reduce concentrations of VOCs in the area of concern in the shallow groundwater unit and in the principal aquifer downgradient of the source areas to federal or state cleanup levels.
- Contain migration of VOCs above cleanup levels in the principal aquifer.
- Prevent use of groundwater containing VOCs above cleanup levels for domestic use.

Cleanup levels for VOCs are represented by the lower of United States Environmental Protection Agency (U.S. EPA) or California Environmental Protection Agency maximum contaminant levels (MCLs) or nonzero maximum contaminant level goals (MCLGs). In cases where MCLs or MCLGs do not exist for a specific chemical, a risk-based concentration (RBC) will be utilized as the cleanup goal.

The technical adequacy of Alternative 8A was evaluated using the same computer model that was used to simulate groundwater flow and solute transport for the six original OU-1 IAFS Addendum alternatives. This allows Alternative 8A to be compared with the other six alternatives. The results of the computer simulation are presented in a memorandum titled Groundwater Modeling of the IDP Preferred Alternative to Remediate the TCE Plume in the Irvine Subbasin, which is included as Attachment 1. This document supplements that memorandum and the OU-1 IAFS Addendum by evaluating Alternative 8A individually and comparatively against the other OU-1 alternatives using the NCP criteria in accordance with the U.S. EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA (U.S. EPA 1988).

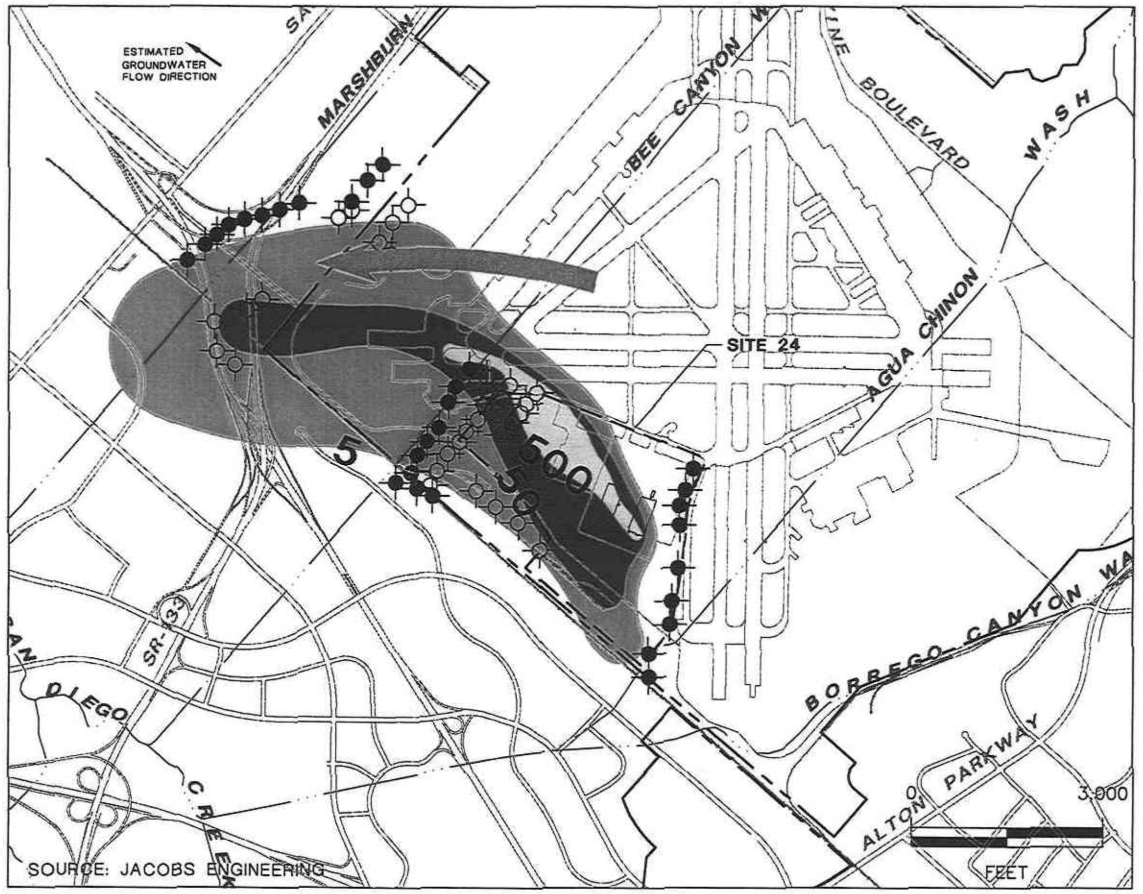
Alternative 8A and the six IAFS alternatives addressed in this technical memorandum focus on remediation of groundwater in the principal aquifer at OU-1 (Site 18), the Regional Groundwater Plume. These alternatives rely on a series of 31 barrier wells at the toe of the groundwater plume in the shallow groundwater unit upgradient of Site 18 to impede the flow of contaminated groundwater from the shallow groundwater unit to the principal aquifer. Separate alternatives have been developed to focus on and optimize remediation of groundwater in the shallow groundwater unit at Site 24 (OU-2A), the VOC source area (BNI 1997).

1 DESCRIPTION OF OU-1 ALTERNATIVES EVALUATED IN THE IAFS ADDENDUM

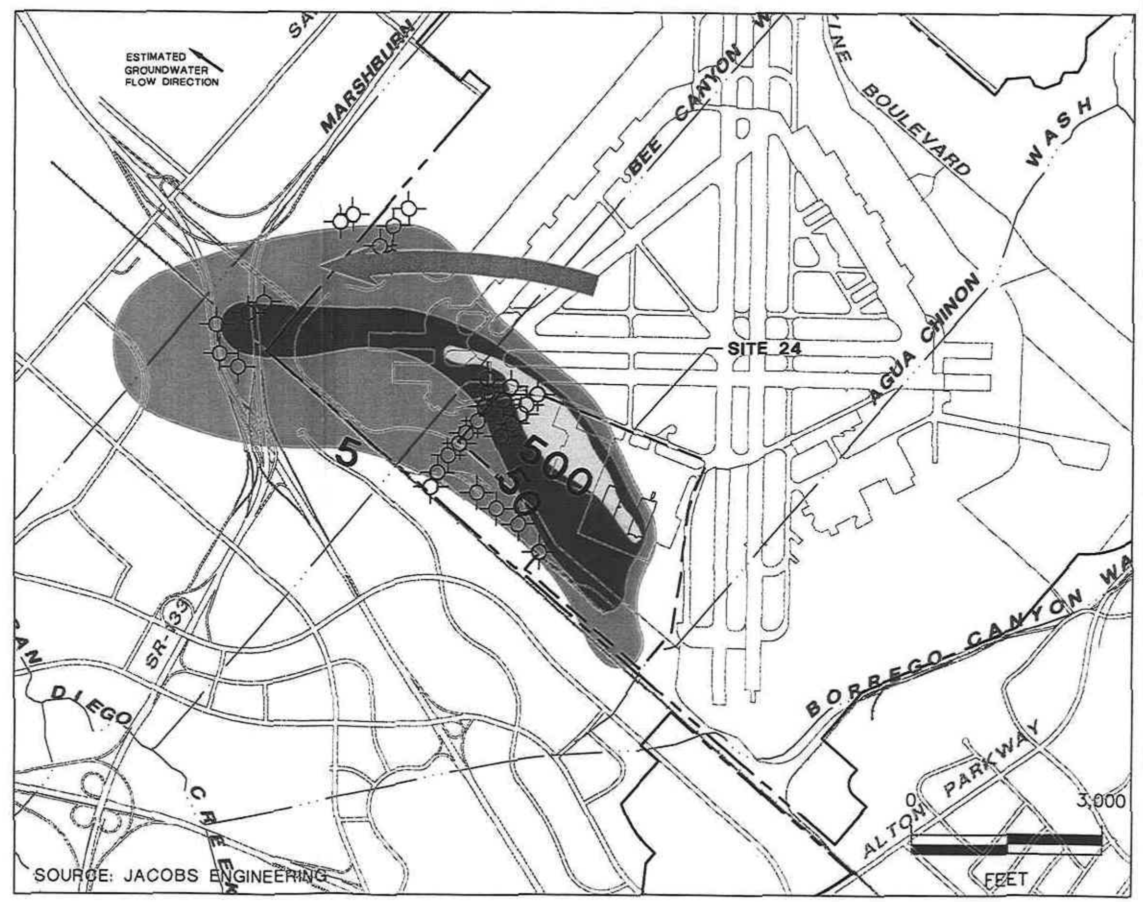
Six alternatives (Alternatives 1, 2A, 6A, 7A, 7B, and 8) were evaluated in the OU-1 IAFS. Alternative 1, the no-action alternative, is required by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to provide a basis from which to develop and evaluate the other remedial alternatives. Under Alternative 1, no remediation measures or land-use controls would be initiated at Site 18. Eventually, the VOC concentrations would decline to the groundwater cleanup goals because of nearby production well pumping and natural attenuation in the aquifer. However, without any remedial action, the length of time required to meet these goals is expected to be greater than 100 years.

Alternative 2A uses separate groundwater extraction, VOC treatment, and groundwater injection facilities for the shallow groundwater unit and principal aquifer. Shallow groundwater is extracted through a series of 31 wells, treated using air stripping, and injected back into the shallow groundwater unit (Figure 1). In the principal aquifer (Figure 2), two extraction wells located at the toe of the trichloroethene (TCE) plume are used to contain groundwater with TCE concentrations above the MCL and remove TCE mass from the VOC plume. After VOC treatment, groundwater is injected upgradient into the principal aquifer through 10 injection wells (Figure 2). Groundwater is monitored using a network of 45 existing and 14 new wells. Remedial goals for groundwater at Site 18 were established for each chemical of concern using federal MCLs and nonzero MCLGs, state primary MCLs for organic compounds, and RBCs. Remediation of contaminated groundwater at Site 18 to these levels is expected to take several decades to complete. In the interim, Alternative 2A will use land-use controls to protect human health and the environment. The land-use controls will prohibit extraction or use of contaminated groundwater; protect extraction and monitoring wells, conveyance lines, and equipment; and allow access to monitor, operate, and maintain the remedial system.

The property containing MCAS El Toro is currently owned by the United States government. However, the Department of the Navy (DON) plans to transfer the property overlying the Site 24 groundwater plume in the future. When this occurs, land-use controls will be implemented through restrictions that will be placed in the deed at the time of property transfer. These restrictions will "run with the land" and will be in effect until cleanup is complete. Use of off-Station groundwater is controlled through a permitting process, requiring that a potential user of groundwater obtains a permit from Orange County Health Care Agency prior to well construction in the MCAS El Toro area. The DON plans to work with the appropriate local authorities to ban new wells in the contaminated area or ensure that extracted groundwater is tested and properly treated prior to domestic (e.g., drinking, cooking, bathing) use. Details of off-Station land-use controls will be provided in the Record of Decision (ROD) for Sites 18 and 24.



ALTERNATIVES 2A, 7A, AND 7B



ALTERNATIVES 6A, 8, AND 8A

LEGEND

ROAD

FREEWAY

MCAS EL TORO BOUNDARY

SITE 24 BOUNDARY

STREAM OR WASH

NORTH
N
TRUE

PROPOSED

MCAS EL TORO INJECTION WELL

MCAS EL TORO EXTRACTION WELL

TCE CONCENTRATIONS IN GROUNDWATER

< 5.0 ug/L (MCL)

5.0 TO 50.0 ug/L TCE

5.0 TO 500.0 ug/L TCE

GREATER THAN 500.0 ug/L TCE

5 INFERRED ISOCONCENTRATION CONTOUR (ug/L)

GROUNWATER FLOW DIRECTION

NOTES:

DATE SAMPLES COLLECTED MARCH 1997

50 AND 500 ug/L CONCENTRATION CONTOURS REVISED TO REFLECT HYDROPUNCH SAMPLES COLLECTED BETWEEN JANUARY AND APRIL 1998.

FOR MULTI-PORT OR CLUSTER WELL LOCATIONS THE HIGHEST CONCENTRATION WAS USED FOR CONTOURING THE PLUME.

Technical Memorandum

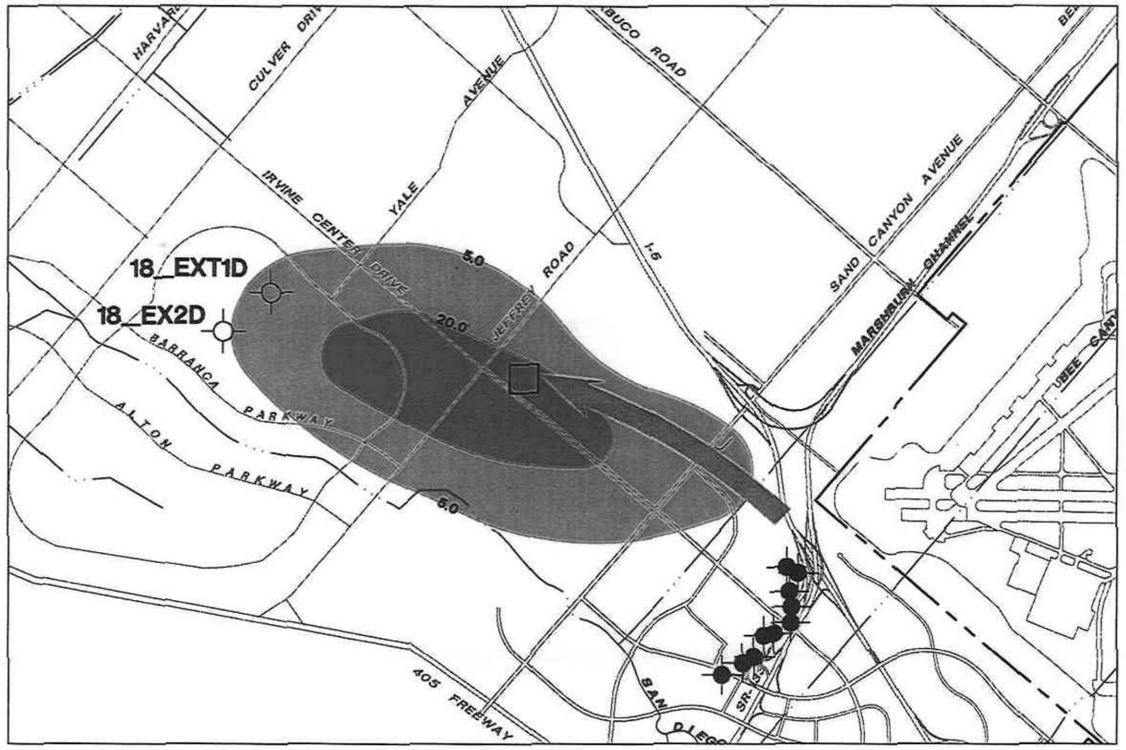
Figure 1

Shallow Groundwater Unit Extraction / Injection Wells

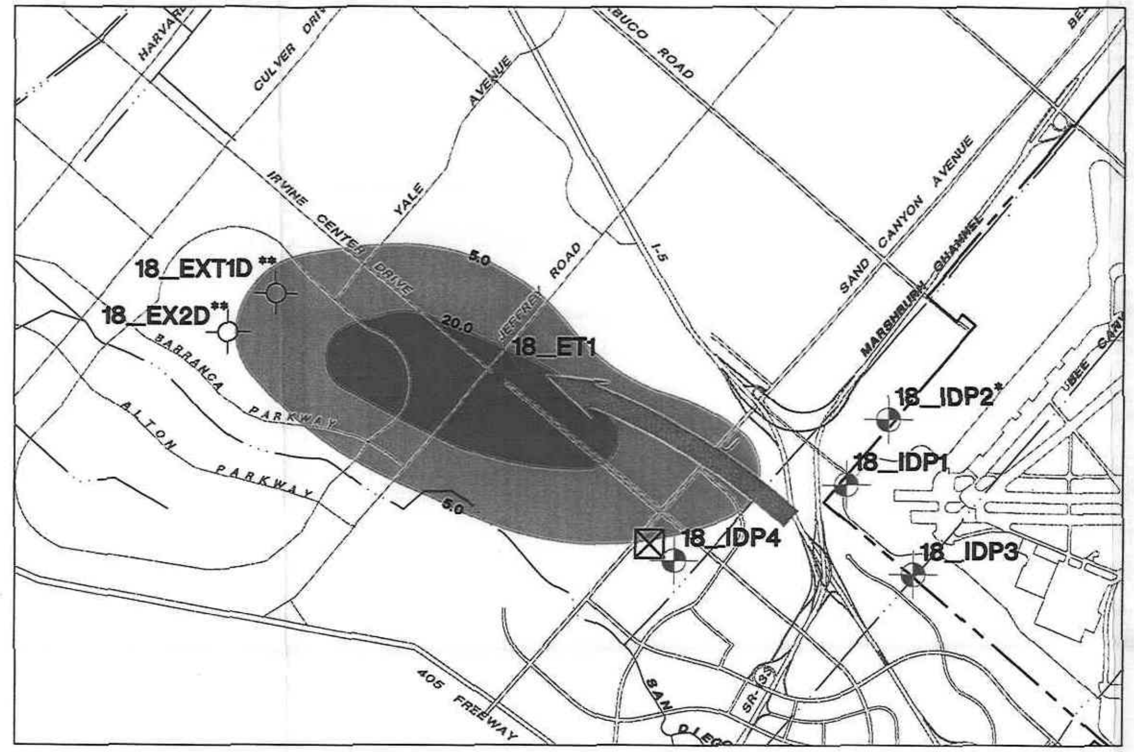
MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

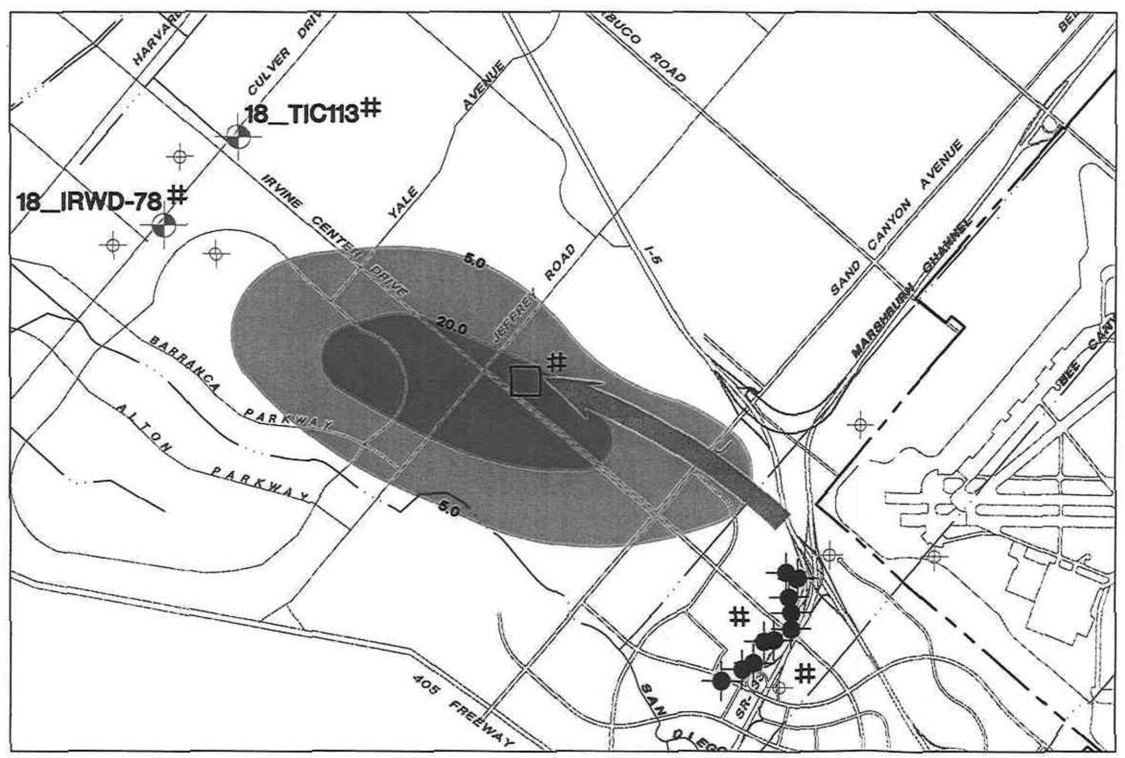
Date: 4/25/01
File No: 187H6335
Job No: 22214-187
Rev No: B



ALTERNATIVE 2A



ALTERNATIVES 6A AND 8



ALTERNATIVES 7A and 7B

TRUE NORTH

N

0 4,500 9,000

FEET

LEGEND

ROAD

FREEWAY

MCAS EL TORO BOUNDARY

STREAM OR WASH

PROPOSED MCAS EL TORO TREATMENT FACILITY LOCATION

PROPOSED IDP TREATMENT FACILITY LOCATION

INJECTION WELLS

MCAS EL TORO INJECTION WELL

EXTRACTION WELLS

MCAS EL TORO EXTRACTION WELL

OCWD/IRRIGATION WELL

MONITORING WELL CLUSTER

TCE CONCENTRATIONS IN GROUNDWATER

< 5.0 ug/L (MCL)

5.0 TO 20.0 ug/L TCE

20.0 TO 50.0 ug/L TCE

5 INFERRED ISOCONCENTRATION CONTOUR (ug/L)

GROUNWATER FLOW DIRECTION

NOTES:

DATE SAMPLES COLLECTED MARCH 1997

50 AND 500 ug/L CONCENTRATION CONTOURS REVISED TO REFLECT HYDROPUNCH SAMPLES COLLECTED BETWEEN JANUARY AND APRIL 1998.

FOR MULTI-PORT OR CLUSTER WELL LOCATIONS THE HIGHEST CONCENTRATION WAS USED FOR CONTOURING THE PLUME.

*18_IDP2 IS A COMPONENT OF ALTERNATIVE 8 ONLY.

**18_EXT1D AND 18_EXT2D ARE NOT USED FOR ALTERNATIVE 8.

NAVY ACQUISITION OF EXTRACTION WELLS 18_IRWD-78 AND 18_TIC113, INSTALLATION OF TREATMENT FACILITY, INJECTION WELLS, AND INJECTION WELL MONITORING WELL IMPLEMENTED AFTER 10 YEARS. (ALTERNATIVE 7B ONLY)

Technical Memorandum

Figure 2

Principal Aquifer Extraction / Injection Wells

MCAS, El Toro, California

BECHTEL

Bechtel National, Inc.

CLEAN II Program

Date: 4/27/01
File No: 187H6336
Job No: 22214-187
Rev No: C

In Alternative 6A, groundwater is extracted from the shallow groundwater unit using the same extraction well system as Alternative 2A (Figure 1) and from the principal aquifer using two wells located at the toe of the TCE plume and four wells located upgradient of the plume (Figure 2). Untreated groundwater from the shallow groundwater unit and principal aquifer is blended and conveyed to the proposed Irvine Desalter Project (IDP) central treatment facility for treatment. The IDP was initiated by the Orange County Water District (OCWD) and the Irvine Ranch Water District (IRWD) to develop a local water supply drawing from the principal aquifer. The treatment facility is also being designed to accept and treat for VOC removal the groundwater that the Marine Corps must remediate. Once the VOCs are removed, the groundwater will be discharged to the remainder of the IDP treatment system for additional treatment and use. However, only the IDP components that contribute to TCE remediation are considered part of the CERCLA remedy. Land-use controls for Alternative 6A are identical to those for Alternative 2A. Groundwater monitoring is similar except that two monitoring wells that were to be added in Alternative 2A to measure the effects of injection will not be used in Alternative 6A because there is no injection in this alternative.

Alternative 7A uses the same shallow groundwater extraction/VOC treatment/injection system as Alternative 2A, but relies on existing production wells and natural attenuation for remediation of the principal aquifer. To ensure that plume movement is halted and remediation is occurring as expected, an enhanced well network will be used to monitor potential plume movement at the downgradient edge of the plume and a contingency plan would be implemented in the event that trigger levels are exceeded in the monitoring wells. Land-use controls are identical to those of Alternative 2A.

Alternative 7B is identical to Alternative 7A except that in Alternative 7B, two existing irrigation wells at Culver Drive (18_IRWD78 and 18_TIC113 [Figure 2]) are assumed to cease operations after 10 years due either to reduced demand for the water or to increasing total dissolved solids concentrations. In Alternative 7B, the DON acquires these wells at that time, treats the extracted groundwater to remove VOCs, and injects the treated groundwater upgradient of the TCE plume in the principal aquifer. Land-use controls are identical to those of Alternative 2A. Monitoring is identical to that of Alternative 7A except that, after 10 years, one new monitoring well cluster would be installed upgradient of the principal aquifer injection well field to monitor water levels and concentrations associated with injection.

Alternative 8 has the same shallow groundwater unit extraction well configuration as Alternative 6A. Groundwater is extracted from the principal aquifer using five wells located upgradient of and within the VOC plume. A sixth well, 18_TIC110, is outside the TCE plume and is not considered part of the response in Alternative 8 even though groundwater from this well is discharged to the IDP along with groundwater from the five CERCLA wells. The extracted groundwater from the principal aquifer is blended with groundwater from the shallow groundwater unit and discharged to the IDP for treatment. Downgradient of the IDP wells, the principal aquifer will be allowed to attenuate naturally. Land-use controls for Alternative 8 are identical to those for Alternative 2A. Monitoring is identical to that of Alternative 7A.

2 DESCRIPTION OF ALTERNATIVE 8A

Alternative 8A was developed by OCWD/IRWD subsequent to the IAFS in response to community concerns about discharging treated groundwater into the potable water supply. Alternative 8A uses the same shallow groundwater unit extraction well configuration and conveyance system as Alternatives 6A and 8 (Figure 1). However, in the principal aquifer, groundwater is collected using two separate extraction and conveyance systems: a potable system and a nonpotable system (Figure 3). Water from each system would remain separate and would not be mixed. Only the nonpotable portion of the system would be considered part of the CERCLA remedy.

The potable system for Alternative 8A consists of four wells screened outside the currently observed VOC plume in the principal aquifer in areas where concentrations of TCE are below the MCL of 5 micrograms per liter (μg/L). This water would be collected, conveyed to the IDP treatment facility, treated, then discharged for domestic use.

The nonpotable system would consist of 2 wells located within the principal aquifer VOC plume, 1 well located at the toe of the TCE plume in the principal aquifer, and 31 wells in the shallow groundwater unit. Groundwater collected from the nonpotable system wells in the principal aquifer and from the shallow groundwater unit would be extracted, blended, and conveyed to the IDP Central Treatment Facility where the groundwater would be treated and released for use as recycled water (i.e., for irrigation and other nonpotable water uses).

The DON, United States Department of Justice (DOJ), and OCWD/IRWD have signed a settlement agreement apportioning costs and defining responsibility for construction and operation of the IDP. The settlement agreement is based on the Alternative 8A well configuration and extraction and treatment system that is described in this memorandum.

The modeling that was performed for Alternative 8A assumed that the nonpotable system would be operated year-round in the shallow groundwater unit and seasonally in the principal aquifer (approximately 5.5 months per year). Groundwater extracted from the shallow groundwater unit will be treated and recycled during summer months and will be injected into the principal aquifer via well 18_IDP1 during winter months. Injection into 18_IDP1 was not simulated in the model but will be further evaluated at the remedial design stage. Groundwater injection would be monitored to ensure that any changes to the VOC plume would be consistent with the computer modeling results.

3 EVALUATION CRITERIA

Each remedial alternative developed for a CERCLA remedial action must be assessed against nine evaluation criteria explicitly defined in the NCP and U.S. EPA guidance. Two of the nine criteria are designated as "threshold criteria." The threshold criteria are related directly to statutory findings that must ultimately be made in the ROD, so each alternative must meet these two criteria:

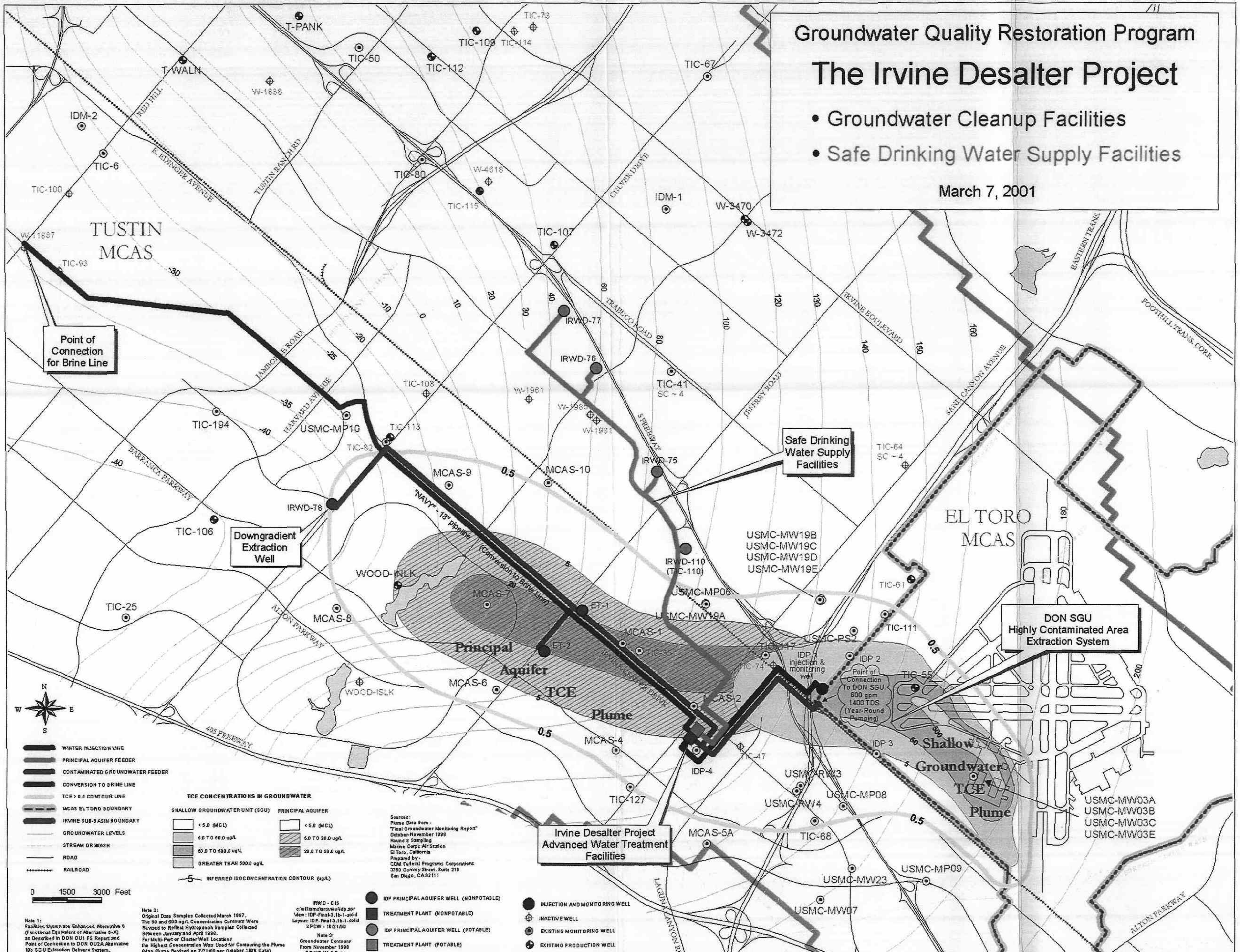

Groundwater Quality Restoration Program
The Irvine Desalter Project
• Groundwater Cleanup Facilities
• Safe Drinking Water Supply Facilities
March 7, 2001
TUSTIN MCAS
EL TORO MCAS
Point of Connection for Brine Line
Safe Drinking Water Supply Facilities
Downgradient Extraction Well
DON SGU Highly Contaminated Area Extraction System
Irvine Desalter Project Advanced Water Treatment Facilities
Principal Aquifer TCE Plume
Shallow Groundwater TCE Plume
"NAVY" - 18" pipeline (Conversion to Brine Line)
Point of Connection To DON SGU 600 gpm 1400 TDS (Year-Round Pumping)
IDP 1 injection & monitoring well
IDP 2
IDP 3
IDP-4
ET-1
ET-2
IRWD-75
IRWD-76
IRWD-77
IRWD-78
IRWD-110 (TIC-110)
T-PANK
T-WALN
TIC-50
TIC-109
TIC-112
TIC-67
IDM-1
IDM-2
TIC-6
TIC-80
TIC-100
TIC-107
TIC-41 SC ~ 4
TIC-64 SC ~ 4
TIC-194
TIC-106
TIC-25
TIC-61
TIC-111
TIC-55
TIC-127
TIC-68
W-3470
W-3472
W-1961
USMC-MP10
MCAS-9
MCAS-10
MCAS-8
MCAS-6
MCAS-4
MCAS-5A
MCAS-2
MCAS-1
WOOD-INLK
WOOD-ISLK
USMC-MW19A
USMC-MW19B
USMC-MW19C
USMC-MW19D
USMC-MW19E
USMC-MP06
USMC-PS2
USMC-MP08
USMC-MP09
USMC-MW23
USMC-MW07
USMC-MW03A
USMC-MW03B
USMC-MW03C
USMC-MW03E
RED HILL
E. EDINGER AVENUE
TUSTIN RANCH RD
JAMBOREE ROAD
HARVARD AVENUE
BARRANCA PARKWAY
CULVER DRIVE
TRABUCO ROAD
JEFFREY ROAD
IRVINE BOULEVARD
SAND CANYON AVENUE
ALTON PARKWAY
405 FREEWAY
5 FREEWAY
LAGUNA CANYON RD
EASTERN TRANS. CORR.
FOOTHILL TRANS. CORR.
WINTER INJECTION LINE
PRINCIPAL AQUIFER FEEDER
CONTAMINATED GROUNDWATER FEEDER
CONVERSION TO BRINE LINE
TCE > 0.5 CONTOUR LINE
MCAS EL TORO BOUNDARY
IRVINE SUB-BASIN BOUNDARY
GROUNDWATER LEVELS
STREAM OR WASH
ROAD
RAILROAD
TCE CONCENTRATIONS IN GROUNDWATER
SHALLOW GROUNDWATER UNIT (SGU)
< 5.0 (MCL)
5.0 TO 50.0 ug/L
50.0 TO 500.0 ug/L
GREATER THAN 500.0 ug/L
PRINCIPAL AQUIFER
< 5.0 (MCL)
5.0 TO 20.0 ug/L
20.0 TO 50.0 ug/L
INFERRED ISOCONCENTRATION CONTOUR (ug/L)
Sources:
Plume Data from -
"Final Groundwater Monitoring Report"
October-November 1998
Round 8 Sampling
Marine Corps Air Station
El Toro, California
Prepared by -
CDM Federal Programs Corporations
3760 Convoy Street, Suite 210
San Diego, CA 92111
0 1500 3000 Feet
Note 1:
Facilities Shown are Enhanced Alternative 8 (Functional Equivalent of Alternative 8-A) as Described in DON OU1 FS Report and Point of Connection to DON OU2A Alternative 10b SGU Extraction Delivery System.
Note 2:
Original Data Samples Collected March 1997.
The 50 and 500 ug/L Concentration Contours Were Revised to Reflect Hydropunch Samples Collected Between January and April 1998.
For Multi-Port or Cluster Well Locations the Highest Concentration Was Used for Contouring the Plume (Map Plume Revised on 7/21/00 per October 1998 Data)
IRWD - GIS
View : IDP-Final-3.1b-1-solid
Layout: IDP-Final-3.1b-1-solid
SPCW - 10/21/99
Note 3:
Groundwater Contours From November 1998 OCWD Well Data
IDP PRINCIPAL AQUIFER WELL (NONPOTABLE)
TREATMENT PLANT (NONPOTABLE)
IDP PRINCIPAL AQUIFER WELL (POTABLE)
TREATMENT PLANT (POTABLE)
INJECTION AND MONITORING WELL
INACTIVE WELL
EXISTING MONITORING WELL
EXISTING PRODUCTION WELL

Figure 3

- overall protection of human health and the environment and
- compliance with applicable or relevant and appropriate requirements (ARARs).

Five of the nine criteria are designated as "balancing criteria." The balancing criteria are the primary criteria for the detailed analysis considering technical, cost, administrative, and risk concerns. The criteria include:

- long-term effectiveness and permanence;
- reduction of toxicity, mobility, or volume;
- short-term effectiveness;
- implementability; and
- cost.

Two of the criteria are designated as "modifying criteria." The modifying criteria are used in the final analysis of remedial alternatives, and are generally used to modify an otherwise acceptable alternative rather than choose among very different alternatives. They are considered after public comment on the draft remedial investigation/feasibility study report and the proposed plan. Modifying criteria include:

- community acceptance and
- state acceptance.

Additional details on each of the criteria are provided below along with the evaluation of Alternative 8A.

4 EVALUATION OF ALTERNATIVE 8A AGAINST NCP CRITERIA

This section evaluates how well Alternative 8A meets the nine NCP criteria discussed above. When appropriate, a clarification of the NCP criterion is provided in italic type above the evaluation.

4.1 Overall Protection of Human Health and the Environment

Protection of human health and the environment is accomplished by eliminating, reducing, or controlling exposures to contaminants at levels established during development of remedial goals. This evaluation is an assessment of how well the alternative protects human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site. The evaluation also examines whether alternatives pose any unacceptable short-term or cross-media impacts.

Alternative 8A provides overall protection of human health by controlling access to the contaminated groundwater, reducing the concentrations of TCE in the principal aquifer and shallow groundwater unit, and minimizing migration of VOC contamination.

Although groundwater at Sites 18 and 24 is not currently being used for potable purposes, U.S. EPA requires that alternatives be evaluated to protect potential future users who might inadvertently use the water for drinking without first treating it to remove VOCs. Alternative 8A would protect future users by including land-use controls to prohibit unauthorized extraction or use of contaminated groundwater before remediation is complete. Once remediation is complete, the residual risk, represented by the cleanup goals (MCLs, nonzero MCLGs, or RBCs), has been determined by U.S. EPA to be allowable.

The shallow extraction wells in Alternative 8A would be designed to contain the shallow TCE plume and prevent migration from the shallow groundwater unit to the principal aquifer. Computer modeling indicates that under Alternative 8A, the VOC plume in the principal aquifer will migrate slightly downgradient and laterally from its current location after 20 years (Attachment 1). However, at no time will the plume impact the four extraction wells associated with the potable water system.

There are no short-term or cross-media impacts expected from Alternative 8A.

4.2 Compliance With ARARs

This criterion assesses the ability of the alternative to meet all ARARs under federal environmental laws and state environmental or facility siting laws. The federal and state ARARs for the OU-1 alternatives were identified in the OU-1 IAFS (JEG 1996b).

Alternative 8A is expected to meet the remedial goals for the aquifer, thereby complying with the substantive requirements of the Comprehensive Water Quality Control Plan of the Santa Ana Regional Water Quality Control Board, federal MCLs and nonzero MCLGs, state primary MCLs for organic compounds, and the Resource Conservation and Recovery Act groundwater protection standards. The time frame required to meet the remedial goals in the principal aquifer would be significant (estimated at 95 years using computer modeling). In the interim, Alternative 8A would rely on institutional controls to prevent domestic use of contaminated groundwater.

Alternative 8A would also comply with:

- Executive Orders on floodplain protection,
- National Archaeological and Historical Preservation Act,
- Clean Air Act, and
- South Coast Air Quality Management District (SCAQMD) requirements for VOCs in emissions from the air stripper.

Some monitoring wells and extraction wells may be located within a 100-year floodplain. These wells will be designed to avoid adverse effects to and preserve the beneficial values of the plain.

VOCs will be treated using air stripping. SCAQMD requirements would be met by using vapor-phase granular activated carbon filters on the off-gas from the air strippers. Any new construction in undisturbed areas would require a Phase I archaeological survey to comply with the National Archaeological and Historical Preservation Act.

4.3 Long-Term Effectiveness and Permanence

This criterion assesses long-term effectiveness and permanence of the alternative and degree of certainty that the alternative will prove successful. Effectiveness and permanence are evaluated with respect to the magnitude of residual risk and to the adequacy of controls for managing remaining residual waste over the long term. Alternatives that offer the highest degree of long-term effectiveness and permanence are those that leave little or no waste remaining at the site; this eliminates long-term maintenance and monitoring and minimizes reliance on land-use controls.

The residual risk remaining when Alternative 8A reaches its cleanup levels is represented by the MCLs, nonzero MCLGs, and RBCs for VOCs, which U.S. EPA has determined are allowable risk levels. Groundwater modeling results indicate that Alternative 8A would reduce concentrations to these levels in the principal aquifer in approximately 95 years. Once the cleanup goals are achieved and confirmed, maintenance, monitoring, and land-use controls would no longer be necessary because unacceptable levels of waste would not remain at the site.

4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion assesses the degree to which the alternative employs recycling or treatment that reduces toxicity, mobility, or volume of hazardous substances. The evaluation addresses the anticipated performance of the treatment technologies that a remedy may employ by considering the amount of waste treated or destroyed, the irreversibility of the treatment process, and the type and quantity of residuals resulting from any treatment process.

Modeling results estimate that Alternative 8A would remove approximately 14,000 pounds of TCE (approximately 70 percent) during the first 20 years of operation. The estimate for TCE mass removal is based on an estimated quantity of approximately 19,500 pounds of TCE mass initially present in groundwater and about 500 pounds of TCE assumed to be introduced to groundwater over a simulation period of 20 years from the on-Station source. Treatment residuals would consist of VOCs adsorbed to carbon. The spent carbon would be transported off-site and regenerated, typically by thermally destroying the VOCs. This would result in permanent destruction of TCE and other contaminants currently present in the groundwater plume.

Mobility would also be reduced because computer modeling of Alternative 8A indicates that the VOC plume will have migrated only slightly beyond its current boundary at the end of 20 years.

4.5 Short-Term Effectiveness

This criterion takes into consideration the protection of on-site workers and the community during the remedial action and the environmental impacts of implementing the action. This criterion also assesses the time necessary to achieve cleanup objectives.

None of the actions to be taken in this alternative are expected to cause adverse short-term health effects. Alternative 8A would involve drilling extraction and monitoring wells; constructing conveyance lines from the wells to the central treatment facility; and operating and maintaining the wells, conveyance piping, and treatment facility. Potential exposure of workers engaged in construction, monitoring, and maintenance activities at Sites 18 and 24 would be mitigated by using a site-specific safety and health plan.

Exposure to community members during construction is not considered plausible. If any exposure did occur, it would most likely result from fugitive dust generated during construction. However, unsaturated soil at Site 18 contains very low levels of VOC contamination, and a risk assessment performed during the remedial investigation at Site 24 (BNI 1997) showed that VOC contaminants present in shallow soil do not pose an unacceptable risk to human health.

Computer modeling of Alternative 8A estimates that the time to reach cleanup goals in the principal aquifer is 95 years.

4.6 Implementability

Implementability refers to the technical and administrative feasibility of implementing the alternative, as well as the availability of necessary goods and services. This criterion includes the ability to construct and operate components of the alternative; the availability of disposal services, storage capacity, equipment, and specialists; the ability to monitor the performance and effectiveness of technologies; and the ability to obtain necessary approvals from regulatory agencies.

The extraction, treatment, and conveyance processes included in Alternative 8A use standard, proven technologies. Because these technologies are generally available and sufficiently demonstrated, difficulties with construction, technical problems, or availability of equipment or services are expected to be minimal.

Alternative 8A will include a monitoring program to track the performance of the remedial action. The monitoring program would provide early warning of changes in contaminant concentrations or potential contaminant migration beyond current plume boundaries that could require contingency actions to attain the remedial goals. Potential contingency actions include increased monitoring frequency, data evaluation, discussion with regulatory agencies, and consideration of actions, if any, needed to protect actual beneficial uses.

Wells located off-Station would require acquisition of property or easements for the construction of extraction wells and conveyance facilities. Coordination with California Transportation Authority or local transportation authorities would be sought if installation of conveyance facilities will affect transportation rights-of-way. Construction on-Station will require coordination with plans for station closure and reuse of the land.

The property that includes Site 24 is scheduled for transfer to the county of Orange. Deed restrictions would be used to implement institutional controls (e.g., restricting extraction or use of groundwater, protecting remediation equipment, and allowing access for monitoring and maintenance of wells and associated piping) on this property. The parcel that includes Site 18 does not belong to the federal government. Local government agencies and water districts have been notified of the groundwater contamination at Site 18. The DON plans to work with the appropriate local authorities to ban new wells in the contaminated area or ensure that water extracted from areas within the plume is tested and properly treated prior to domestic use.

Alternative 8A assumes that a settlement agreement will be reached between the DON and OCWD/IRWD apportioning costs and defining responsibilities for construction and operation of the IDP. This settlement agreement has been signed by DON, DOJ, and OCWD/IRWD and, therefore, considered administratively feasible.

4.7 Cost

The estimated cost of Alternative 8A is $33.6 million. This includes approximately $16.2 million in capital costs and $17.5 million in operations and maintenance (O&M) and monitoring costs. The costs are summarized on Table 1. For the purpose of allowing cost comparisons, these costs assume that all remedial alternatives are operated for 40 years in the shallow groundwater unit and 40 years in the principal aquifer.

Monitoring costs (i.e., capital costs for monitoring wells and O&M costs associated with monitoring and costs for constructing and maintaining the extraction and conveyance system for the shallow groundwater unit) are assumed to be the same as for Alternative 8. Because seasonal injection of groundwater into well 18_IDP1 is optional, injection is assumed to be at the expense of OCWD/IRWD. Therefore, injection costs are not included in the estimate for Alternative 8A.

Capital costs include both direct and indirect costs required for implementation of a remedial action. Direct costs include construction costs or expenditures for equipment, labor, and materials; indirect costs include engineering, permitting (as required), construction management, and other services. Annual O&M costs (labor, maintenance materials, energy, and purchase services) include those O&M costs that may be incurred even after the initial remedial activity is complete.

4.8 State Acceptance

State acceptance of Alternative 8A will be evaluated based on comments on the groundwater modeling results for Alternative 8A (Attachment 1) and comments on this evaluation document.

4.9 Community Acceptance

Following review by U.S. EPA and the state agencies, the Proposed Plan for Sites 18 and 24 will be submitted for public review. The Proposed Plan will describe the remedial alternative the DON considers most appropriate for groundwater at Site 18 and soil and groundwater at Site 24. Public comments will be accepted during the public comment period and considered in developing any final modifications to the selected remedy. Agency and public comments received during the public comment period and responses to those comments will be included in the Responsiveness Summary portion of the ROD.

Table 1
Summary Cost Estimate for Alternative 8A

Description	DON Cost	Cost Rationale
CAPITAL COSTS		
Shallow Groundwater Unit		
Extraction System	$2,199,600	Same as Alternative 6A & 8
Conveyance	$1,511,500	Same as Alternative 6A & 8
Subtotal – Shallow Groundwater Unit	*$3,711,100*	
Groundwater Monitoring Wells		
Monitoring Wells	$1,037,500	Same as Alternative 8
Subtotal MCAS El Toro Components	*$4,748,600*	
MCAS El Toro Components with Allowances	*$8,450,000*	
MCAS El Toro Replacement Costs	*$140,000*	Same as Alternative 8
OCWD Components*		
Cost from Settlement Agreement	$7,572,000	Based on settlement agreement
Subtotal OCWD Components	*$7,572,000*	
CAPITAL COST TOTAL	$16,162,000	
O&M COSTS		
Principal Aquifer		
OCWD Components		
O&M Cost Associated with IDP (PW 40 years)	7,339,000	Based on settlement agreement
Cost to Treat SGU Groundwater (40 years)	$3,119,200	Derived from settlement agreement
Subtotal – OCWD Components	*$10,458,200*	
MCAS El Toro Components		
Shallow Groundwater Unit		
Extraction System	$37,150	Same as Alternative 6A & 8
Conveyance	$89,250	Same as Alternative 6A & 8
Subtotal – Shallow Groundwater Unit	*$126,400*	
Groundwater Monitoring Wells		
Monitoring Wells	$196,200	Same as Alternative 8
MCAS El Toro O&M Cost Subtotal	$322,600	
MCAS El Toro O&M Cost Total (10% Contingency on non-OCWD Components)	$354,900	
PRESENT WORTH		
Capital Costs with Allowances	$16,162,000	
O&M Costs for MCAS El Toro Components (PW 40 years)	$7,024,100	
O&M Costs for OCWD Components (PW 40 years)	$10,458,200	
Present Worth Total	$33,644,300	

(table continues)

Table 1 (continued)

Note:
* includes principal aquifer extraction wells and conveyance

Acronyms/Abbreviations:
DON – Department of the Navy
IDP – Irvine Desalter Project
MCAS – Marine Corps Air Station
O&M – operation and maintenance
PW – present worth
SGU – shallow groundwater unit

5 COMPARISON OF OU-1 REMEDIAL ALTERNATIVES

This section compares Alternative 8A with the six OU-1 alternatives presented in the IAFS Addendum in terms of how well they meet the nine NCP criteria. State and community acceptance of the alternatives will be evaluated following the public comment period. However, several focus group meetings have been held by OCWD/IRWD to assess the community acceptance of the IDP. The results of these meetings are summarized below under "Community Acceptance" (Section 5.9).

Reviewers should refer to the OU-1 IAFS (JEG 1996c) and IAFS Addendum (JEG 1996a) for a description of the original OU-1 alternatives and backup data on their performance and to the modeling report (Attachment 1) for backup data on the performance of Alternative 8A.

5.1 Overall Protection of Human Health and the Environment

Except for the no-action alternative (Alternative 1), all the OU-1 alternatives reduce long-term risks to human health by inhibiting contaminant migration from the shallow on-Station source area at Site 24. These alternatives reduce the potential impact of continued contaminant migration on downgradient areas and protect future uses of less contaminated and currently uncontaminated areas of the shallow groundwater unit.

Particle-tracking results indicate that all the alternatives, including Alternative 1, provide eventual containment of the principal aquifer VOC plume east of Culver Drive. Groundwater modeling results indicate that only limited migration of the leading edge of the principal aquifer VOC plume occurs for all alternatives during the 20-year simulation period.

Under each alternative except for Alternative 1, extracted groundwater would be treated to remove VOCs using activated carbon either directly from the groundwater or from the off-gas from air stripping of the groundwater. Spent carbon is usually regenerated, which permanently destroys the VOCs.

Alternatives 6A and 8 provide treatment of the extracted groundwater to VOC concentrations considered by the state and U.S. EPA to be safe for domestic use. Alternative 8A provides treatment to the same levels but does not propose reuse of the treated groundwater for domestic purposes. Alternatives 2A, 7A, and 7B reduce VOCs to levels considered safe for domestic use and inject the treated groundwater back to the aquifer.

In Alternatives 2A, 6A, 7A, 7B, 8, and 8A the DON would protect public health by placing land-use restrictions on the Site 24 property at the time of property transfer to prevent use of contaminated groundwater for domestic purpose, prevent disturbance of monitoring equipment, and allow DON and regulatory agency personnel to access the site to monitor and maintain the remedy. Off Station, the DON will work with the appropriate local authorities to ban new wells in the contaminated area or ensure that any extracted groundwater is tested and properly treated prior to domestic use. These land-use controls would remain in effect until cleanup is complete.

5.2 Compliance With ARARs

Alternative 1, as a no-action alternative, does not trigger ARARs. The remaining alternatives are expected to comply with ARARs. Variations among Alternatives 2A, 6A, 7A, 7B, 8, and 8A are related to performance rather than compliance with ARARs. Alternatives 7A, 7B, 8, and 8A would take longer to achieve MCLs in the principal aquifer than Alternatives 2A and 6A. The contingency plans developed for Alternatives 7A, 7B, and 8 include comprehensive monitoring and provisions to mitigate adverse impact to beneficial uses of the principal aquifer due to unanticipated migration of TCE. A similar contingency plan will be developed for Alternative 8A during the remedial design phase.

5.3 Long-Term Effectiveness and Permanence

The residual risk remaining when all alternatives reach their cleanup goals is represented by the MCLs, nonzero MCLGs, and RBCs for VOCs. The cleanup goal is identical for all alternatives, although the time to reach this goal differs significantly among alternatives. (Time to reach cleanup goals is shown in Table 2 and discussed under "Short-Term Effectiveness.")

Residual risk for an alternative can also be evaluated by looking at the amount of area that remains contaminated at concentrations exceeding the remedial goals. Table 3 shows the simulated TCE plume area (greater than 5 μg/L) at the end of 20 years under each alternative. As the table shows, Alternatives 6A and 8 are the most effective in reducing the total area of the principal aquifer plume that exceeds the remedial goals, closely followed by Alternatives 2A and 8A. These four alternatives reduce the area to approximately 900 to 1,100 acres. Alternatives 7A and 7B are less effective, reducing the principal aquifer plume to 1,303 to 1,308 acres. Alternative 1 is the least effective, leaving approximately 1,400 acres of groundwater containing concentrations of TCE above the MCL in the principal aquifer at the end of 20 years.

Table 2
Overview of Remedial Alternatives

Alternative	SHALLOW GROUNDWATER UNIT Extraction/ Injection Wells (number)	New MCAS Treatment Facility	Treatment Rate (gpm)	Discharge Option	PRINCIPAL AQUIFER Extraction/ Injection Wells (number)	New MCAS Treatment Facility	Treatment Rate (gpm)	Discharge Option	TCE Mass Removed in 20 Years (pounds)	Simulated Time to Clean Up Principal Aquifer (years)	Present Worth Cost[a] ($ million)
1	0/0	No	0	NA	0/0	No	0	NA	3,110	> 100	0
2A	31/31	Yes	1,260	Injection	2/10	Yes	2,000	Injection (years 0–20)	12,540	43	56.4
6A	31/0	No (uses IDP)	1,260	To IDP	MCAS: 2/0 OCWD: 4/0	No (uses IDP)	MCAS: 2,000 OCWD: 2,440	IDP (potable)	13,750	49	40.3[b]
7A	31/31	Yes	1,260	Injection	0/0	No[c]	0[c]	NA	11,830	60	34.0
7B	31/31	Yes	1,260	Injection	2/10 (years 11–20)[c]	Yes[c]	2,000[c]	Injection (years 11–20)	11,750	54	48.2
8	31/0	No (uses IDP)	1,260	To IDP	CERCLA: 5/0[c]	No (uses IDP)[c]	4,400[c]	IDP (potable)[c]	13,200	70	32.3[b]
8A	31/0	No (uses IDP)	1,260	To IDP	CERCLA: 3/0 Potable: 4/0	No (uses IDP)	CERCLA: 2,500	IDP (nonpotable)	14,000	95	33.6

Notes:
[a] present worth cost is based on 40 years of operation and maintenance
[b] based on a 50 percent share of the dual-purpose components
[c] these values are updated from the values presented in Attachment A table titled "Overview of Remedial Alternatives"

Acronyms/Abbreviations:
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
gpm – gallons per minute
IDP – (OCWD) Irvine Desalter Project
MCAS – Marine Corps Air Station
NA – not applicable
OCWD – Orange County Water District
TCE – trichloroethene

Table 3
Simulated TCE Plume Area in the Principal Aquifer After 20 Years

Alternative	TCE PLUME AREA GREATER THAN 5 µg/L (acres) Principal Aquifer
1	1,428
2A	1,082
6A	939
7A	1,308
7B	1,303
8	979
8A	1,073

Acronyms/Abbreviations:
µg/L – micrograms per liter
TCE – trichloroethene

5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Table 4 presents the amount of TCE mass removed by extraction and biodegradation and the combined total. The table also shows the difference in mass removed after 20 years (amount of additional mass removed, and the relative difference) among the alternatives.

Except for Alternative 1, all the alternatives are estimated to remove approximately 12,000 to 14,000 pounds of TCE from the shallow groundwater unit and principal aquifer combined during the first 20 years of operation. Alternative 8A removes the most TCE (14,000 pounds). Alternative 1 removes approximately 3,110 pounds of TCE. This removal occurs as a result of pumping at the irrigation wells located at the downgradient edge of the plume (580 pounds) and as a result of biodegradation (2,530 pounds). The other OU-1 alternatives remove approximately 3 times (2.8 to 3.5 times) more mass (greater by approximately 9,000 additional pounds) than Alternative 1.

Alternatives 6A, 8, and 8A, which include both a shallow unit extraction system and additional principal aquifer extraction wells, remove the most mass relative to Alternative 1 (3.4, 3.2, and 3.5 times, respectively). Alternative 2A removes 3 times more mass than Alternative 1. Although Alternative 2A also includes shallow groundwater unit and principal aquifer extraction systems, the principal aquifer extraction wells pump less water (a total of 2,000 gallons per minute [gpm]) than Alternative 6A (4,400 gpm), 8 (4,400 gpm), and 8A (2,500 gpm). Alternatives 7A and 7B remove slightly less mass than the other active alternatives (2.8 times more than Alternative 1) because they do not include pumping other than that of the Culver Drive wells (18_IRWD78 and 18_TIC113).

Table 4
Simulated TCE Mass Removed After 20 Years

Alternative	TCE MASS REMOVED (pounds) By Extraction	By Biodegradation	Total	COMPARISON AGAINST NO ACTION Additional TCE Mass Removed (pounds)	Number of Times More TCE Mass Removed
1	580	2,530	3,110	NA	NA
2A	10,750	1,790	12,540	9,430	3.0
6A	12,270	1,480	13,750	10,640	3.4
7A	10,040	1,790	11,830	8,720	2.8
7B	9,950	1,800	11,750	8,640	2.8
8	11,710	1,490	13,200	10,090	3.2
8A	12,400	1,600	14,000	10,890	3.5

Acronyms/Abbreviations:
NA – not applicable
TCE – trichloroethene

The model simulations indicate that the estimated amount of mass removed by biodegradation of TCE is greater for Alternative 1 (approximately 2,500 pounds) than the other alternatives (approximately 1,500 to 1,800 pounds) because more mass is available in the system to biodegrade (less mass is removed by pumping).

5.5 Short-Term Effectiveness

The short-term hazards from construction of the alternatives (other than Alternative 1) are approximately equal. Alternatives 6A, 8, and 8A require less construction because they do not include injection wells and would be expected to consequently pose the least risk to workers from construction activities.

The risk from implementing all action alternatives can be readily controlled by use of a site-specific safety and health plan.

Table 2 presents the approximate time required to reach the TCE MCL for all the alternatives in the principal aquifer, as well as the total TCE mass removed at the time of cleanup. Cleanup times were simulated for comparison purposes only (not for predicting an absolute number of years for cleanup).

Alternative 2A has the shortest estimated time to clean up the principal aquifer (43 years), followed by Alternatives 6A and 7B (49 and 54 years, respectively), and then Alternatives 7A, 8, and 8A (60, 70, and 95 years, respectively). Alternative 2A would take the least amount of time to clean up the principal aquifer, because it includes both upgradient principal aquifer injection wells (2,000 gpm) and two MCAS El Toro principal aquifer extraction wells (2,000 gpm) located at the downgradient edge of the TCE plume. The injection wells flush contamination from the aquifer and increase the hydraulic gradient towards the downgradient extraction wells. The two extraction wells intercept TCE contamination prior to migration to the Culver Drive wells.

Alternative 6A (49 years) reaches the cleanup goal 6 years behind Alternative 2A (43 years). Alternative 6A includes extraction wells at the downgradient edge of the TCE plume in the principal aquifer, as does Alternative 2A; however Alternative 2A also includes injection of the treated groundwater into the principal aquifer. Alternative 7B, which reaches cleanup 5 years behind Alternative 6A, does not acquire two existing irrigation wells at the leading edge of the TCE plume or begin extracting and treating the groundwater from these wells and injecting the treated groundwater back into the principal aquifer until 10 years after the start of remedial action.

Alternatives 7A and 8 are slower at cleaning up the principal aquifer (60 and 70 years, respectively) because they do not include principal aquifer injection wells and because they rely on an element of natural attenuation to remediate groundwater downgradient of the extraction wells in the principal aquifer. Alternative 8A requires the longest time to remediate the principal aquifer; however, the effect of seasonal injection was not evaluated in the computer simulation. Injection helps flush contamination from the aquifer and increases the hydraulic gradient toward the extraction wells. The potential for reducing cleanup time due to seasonal injection will be evaluated during remedial design.

5.6 Implementability

From a technical perspective, all the alternatives are readily implementable. None requires expertise or materials that are difficult to obtain. Alternatives 6A and 8 do not require injection wells, which makes them less complex than Alternatives 2A, 7A, 7B, and 8A and, to that extent, they are more easily implementable. An injection system increases the complexity of construction, as well as the complexity of long-term monitoring for performance while the alternative is being operated. Alternative 1 requires no action to implement but also provides the least benefit.

From an administrative perspective, Alternatives 6A, 8, and 8A require that the DON reach an agreement with another party, whereas Alternatives 2A and 7A are implemented by the DON only. If the Culver Drive wells are no longer used for irrigation or reclaimed water in the future, Alternative 7B could require that an agreement be reached with owners of the wells to use them. If the DON is not able to reach an agreement with these owners, the alternative could still be implemented by having the DON install new wells.

All the active alternatives require acquisition of land for off-Station treatment and/or well installation. Alternatives 6A, 8, and 8A do not provide an on-Station injection system and may be more amenable to reuse of the station following property transfer. Alternatives 6A and 8 are also less technically complex because they do not include injection wells. Alternative 8A is somewhat more technically complex than the other IDP alternatives because it consists of two treatment trains.

All of the active alternatives require land-use controls to prevent domestic use of contaminated groundwater. Controls for on-Station property will be established through deed restrictions and developed in conjunction with local authorities. It is expected that controls will be applied at the time the property owner applies for a well permit. All active alternatives are equal in terms of implementability of land-use controls.

Alternative 7A does not include any extraction or injection wells in the principal aquifer and does not rely on any agreements with other entities. However, it is expected that this alternative could meet with regulatory and community resistance because it relies solely on monitored natural attenuation to remediate the principal aquifer and does not attempt to use groundwater from the principal aquifer for beneficial purposes.

5.7 Cost

The relative cost of each alternative is presented in Table 5. This table summarizes the capital and O&M costs and present worth for Alternatives 1, 2A, 6A, 7A, 7B, 8, and 8A based on 40 years of operation in the shallow groundwater unit and principal aquifer. Alternatives 6A, 8, and 8A rely on the IDP to treat contaminated groundwater from the shallow groundwater unit and principal aquifer. The cost that is shown in Table 5 for Alternatives 6A and 8 assumes that the DON will bear 50 percent of the cost of the dual-purpose IDP components associated with the IDP and 100 percent of the cost of components associated with the CERCLA remedy. The IDP portion of the cost of Alternative 8A is based on the terms of the actual Settlement Agreement.

Table 5
Comparison of Costs of OU-1 Remedial Alternative
Based on 40 Years of Operation
(in millions of dollars)

Alternative	Capital Cost	Present Worth of O&M	Total Present Worth
1	0	0	0
2A	29.9	26.5	56.4
6A	21.3	19.0	40.3
7A	18.0	16.0	34.0
7B	25.9	22.3	48.2
8	17.1	15.2	32.3
8A	16.2	17.5	33.6

Acronyms/Abbreviations:
O&M – operation and maintenance
OU – operable unit

Alternatives 7A, 8, and 8A are the least costly of the OU-1 alternatives, with a total present worth cost of $34, $32.3, and $33.6 million, respectively. Alternatives 2A and 7B are the most costly alternatives considered for implementation at OU-1, primarily because of the use of injection wells upgradient of the plume in the principal aquifer.

5.8 State Acceptance

State acceptance of the alternatives will be evaluated following submittal of the draft Proposed Plan to the regulatory agencies.

5.9 Community Acceptance

In general, community acceptance is evaluated following the public comment period. In this case, focus group meetings have already been held by IRWD/OCWD regarding public acceptance of treated water. The focus groups indicated that the public is not receptive to the reuse of water that is currently contaminated above the MCLs for drinking-water purposes, even though treatment would reduce the concentrations of VOCs to a level well below regulatory threshold limits. Therefore, the DON anticipates that Alternatives 6A and 8, which extract groundwater from the leading edge of the plume or within the plume and treat the water for domestic use, may not be acceptable to the public.

6 REFERENCES

Bechtel National, Inc. 1997. Draft final Phase II Remedial Investigation Report. Operable Unit 2A – Site 24. March.

BNI. *See* Bechtel National, Inc.

Jacobs Engineering Group, Inc. 1996a. MCAS El Toro Draft final Operable Unit 1 Interim-Action Feasibility Study Report Addendum. Volume IX of IX of the OU-1 RI/FS Report. August.

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JEG. *See* Jacobs Engineering Group, Inc.

United States Environmental Protection Agency. 1988. Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA. Office of Emergency and Remedial Response.

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ATTACHMENT 1

GROUNDWATER MODELING OF THE IDP PREFERRED ALTERNATIVE TO REMEDIATE THE TCE PLUME IN THE IRVINE SUBBASIN

Modeling of the Irvine Desalter Project Preferred Alternative to Remediate the TCE Plume in the Irvine Subbasin

PREPARED FOR: Richard Bell, P.E.
Manager, Planning and Resources
Irvine Ranch Water District

PREPARED BY: Natasha Raykhman, R.G./CH2M HILL

DATE: November 16, 2000

REGISTERED GEOLOGIST ☆ STATE OF CALIFORNIA ☆ NATALIA V. RAYKHMAN NO. 6868

Introduction

This memorandum presents the results of the groundwater and solute transport modeling performed for the evaluation of the Irvine Desalter Project (IDP) preferred alternative to remediate a plume of trichloroethylene (TCE) in the Irvine Subbasin originating from Marine Corps Air Station (MCAS) El Toro, California. Several remedial alternatives for the TCE plume were previously developed as part of the Operable Unit 1 Interim Action Feasibility Study (OU1 IAFS). The preferred alternative was developed by the Irvine Ranch Water District (IRWD) and Orange County Municipal Water District (OCWD) to address concerns from the community associated with the OU1 IAFS alternatives, such as using treated groundwater that had previously contained TCE as potable water supply.

Under the proposed IDP preferred alternative, groundwater for the potable system would be extracted from areas where TCE concentrations are below the State and Federal Maximum Contaminant Level (MCL) for drinking water. Water pumped from wells in areas with TCE concentrations above the MCL would be treated and discharged to the non-potable water system. It is also important to note that the preferred alternative addresses concerns related to the remediation of the Principal Aquifer, and does not propose any changes in the Shallow Groundwater Unit compared to the OU1 IAFS scenarios*.

IDP preferred alternative was developed using the numerical CFEST groundwater flow and solute transport model of the Irvine Subbasin. CH2M HILL used the same model (i.e., the same numerical code and input parameters as well as the same modeling assumptions) to evaluate remedial alternatives for the OU1 IAFS (Draft Addendum CTO 0145, August 8, 1996). The use of the same model for simulating the new alternative allows the comparative evaluation of the new alternative relative to the previously developed scenarios.

A brief description of the technical approach, proposed IDP preferred alternative wellfield and simulated results is presented below.

* Groundwater extracted from the Shallow Groundwater Unit will be used in non-potable system during summer months, and will be injected into the Principal Aquifer via well IDP-1 during winter months. Injection into IDP-1 was not simulated as part of this work and will be further evaluated at the remedial design stage.

Technical Approach

The objective of this groundwater modeling study is to comparatively evaluate the proposed IDP preferred alternative relative to the scenarios developed during the OU1 IAFS (Draft Addendum CTO 0145; August 8, 1996). To support this evaluation, groundwater flow and TCE transport under the pumping conditions of the proposed IDP preferred alternative were numerically simulated using the CFEST model of the Irvine Subbasin.

All model input files used to simulate IDP preferred alternative were the same as those used to simulate OU1 IAFS scenarios (Draft Addendum CTO 0145; August 8, 1996). This includes hydraulic parameters, initial conditions (i.e., initial TCE concentrations), TCE source term (i.e., TCE mass that is introduced to the aquifer from the vadose zone), retardation, and biodegradation half-life of TCE. Similar to the OU1 IAFS modeling, a quarter-of-a-year time step was used for simulating IDP preferred alternative.

Simulations of IDP preferred alternative included a 20-year groundwater flow and solute transport transient run (i.e., water levels and TCE concentrations change with time) to evaluate the impact of this alternative on groundwater levels and TCE concentrations in the Principal Aquifer of the Irvine Subbasin. It is not expected that IDP preferred alternative would have an impact on the remediation of the TCE and benzene plume in the Shallow Groundwater unit, because the shallow wellfield does not change under this alternative compared to other OU1IAFS scenarios. Additional modeling may be conducted, however, at the remedial design phase to further assess these issues.

Transient particle tracking for the same 20-year period was performed based on the simulated flowfield to evaluate advective (i.e., the most conservative) transport of TCE from the area where TCE concentrations in groundwater exceed MCL. Particle tracking was used to evaluate the ability of IDP preferred alternative to prevent further spreading of TCE and contain the TCE plume.

In addition, a 150-year model run was performed to estimate the approximate cleanup time for the Principal Aquifer. Similar to the OU1 IAFS modeling, the cleanup estimates assumed that the TCE source was removed and the additional mass of TCE (i.e., in excess of initial conditions) was no longer introduced to the aquifer.

Description of IDP Preferred Alternative

The locations of wells and flowrates for IDP preferred alternative are shown on the attached figure. This alternative considers four categories of extraction wells, including (1) existing production wells, (2) IDP potable water wells, (3) IDP non-potable wells, and (4) shallow extraction wells. As previously mentioned, IDP preferred alternative addresses concerns and issues associated with the remediation of the Principal Aquifer, but the shallow extraction wellfield under this alternative is the same as that in the previous OU1 IAFS alternatives.

<u>Existing Production Wells</u>: These wells are TIC-55, TIC-72, TIC-106, TIC-107, TIC-109, TIC-112, TIC-113, North Lake well, and Osumi. All these wells are screened in the Principal Aquifer. With the exception of the North Lake well, these wells are pumped seasonally (i.e., only during the summer months) and are used primarily for irrigation. The simulated flowrates of these wells were defined based on their average production for the period from 1995 through 1997. Most of these wells, with the exception of the North Lake well, are located outside the currently observed TCE plume area (i.e., outside the area with the measured TCE concentrations above MCL).

IDP Potable Water Supply Wells: These wells are IRWD-75, IRWD-76, IRWD-77, and IRWD-110 (TIC-110). All these wells are screened in the Principal Aquifer. All potable water wells are pumped continuously throughout the year. These wells are located outside the currently observed TCE plume area.

IDP Non-Potable Water Supply Wells: These wells are IRWD-78, ET-1, and ET-2. All these wells are screened in the Principal Aquifer. Wells ET-1 and ET-2 are located within the currently observed TCE plume area. Due to their locations in the areas of relatively high TCE concentrations, these wells are effective in removing TCE from the Principal Aquifer. Well IRWD-78 is located at the toe of the TCE plume and is used for containing the plume. IDP non-potable water wells are pumped seasonally.

Shallow Extraction Wells: A total of 31 extraction wells screened in the Shallow Groundwater Unit were assumed for this analysis. Similar to the remedial scenarios developed in the OU1 IAFS (Draft Addendum CTO 0145; August 8, 1996), the continuous pumping of shallow extraction wells with a total flowrate of 1,260 gallons per minute (gpm) was simulated for IDP preferred alternative. It is understood, however, that the locations and flowrates of the shallow extraction wells will change based on the findings of the OU2 and remedial design investigations.

Modeling Results

The results of the groundwater modeling are presented in the attached figures and tables. These results include the following:

- Simulated Water Levels and Groundwater Pathlines in the Principal Aquifer after 20 years
- Simulated TCE Concentrations in the Principal Aquifer after 20 years (Active Source Scenario)
- Simulated TCE Concentrations in the Principal Aquifer after 30, 40, 60, and 90 years (No Source Scenario)
- Simulated Capture Zones of Potable Wells in the Principal Aquifer after 50 years
- Estimates of the TCE mass removed from the Principal Aquifer after 20 years
- Estimates of the TCE cleanup time in the Principal Aquifer
- Estimates of the TCE plume area greater than MCL in the Principal Aquifer after 20 years

Based on these results, IDP preferred alternative is comparable with the OU1 IAFS alternatives with regard to the ability to contain and remediate the TCE plume. The attached figures show that the TCE plume in the Principal Aquifer is contained and decreased in size substantially after 20 years of extraction. The total amount of the TCE mass removed after 20 years is 14,000 pounds (lbs) including 12,400 lbs by wells and 1,650 by biodegradation. The TCE plume area in the Principal aquifer after 20 years is estimated to be 1,073 acres. The cleanup time for the Principal Aquifer is estimated to be within 95 years.

Summary

The evaluation of IDP preferred alternative presented in this memorandum is based on the simulation of the numerical model of the Irvine Subbasin. Although the model incorporates a large body of information and professional judgment gained from the remedial investigation (RI) and regional studies, it represents a significant simplification of the actual hydrogeologic conditions in the Irvine Subbasin. Consequently, local conditions may vary from the regional results. However, modeling results appear reasonable when compared with available data, and when used to assess regional contaminant migration patterns and the relative effectiveness of the remedial scenarios.

Overview of Remedial Alternatives											
	Shallow Groundwater Unit				Principal Aquifer						
Alternative	Extraction/ Injection Wells (number)	New MCAS Treatment Facility?	Treatment Rate (gpm)	Discharge Option	Extraction/ Injection Wells (number)	New MCAS Treatment Facility?	Treatment Rate (gpm)	Discharge Option	TCE Mass Removed in 20 yrs (lbs)	Simulated Time to Clean Up Principal Aquifer (yrs)	Present Worth Cost[1] ($ million)
1	0/0	No	0	N.A.	0	No	0	N.A.	3,110	>100	0
2A	31/31	Yes	1,260	Injection	2/10	Yes	2,000	Injection (Year 0-20)	12,540	43	56.4
6A	31/0	No	1,260	To IDP	MCAS: 2/0 OCWD: 4/0	No	OCWD: 5,700	To IDP	13,750	49	32.6[2] 40.3[3]
7A	31/31	Yes	1,260	Injection	0	N.A.	N.A.	N.A.	11,830	60	34.0
7B	31/31	Yes	1,260	Injection	0	N.A.	N.A.	Injection (Year 11-20)	11,750	54	48.2
8	31/0	No	1,260	To IDP	0	N.A.	N.A.	N.A.	13,200	70	23.7[2] 32.3[3]
IDP Preferred Alternative	31/0	No	1,260	To IDP	3	IDP	2500	IDP (Non-Potable)	14,000	95	

gpm = gallons per minute
IDP = OCWD Irvine Desalter Project
lbs = pounds
MCAS = Marine Corps Air Station El Toro
N.A. = Not applicable
OCWD = Orange County Water District
PA = Principal Aquifer
SGU = Shallow Groundwater Unit
TCE = trichloroethylene
yrs = years

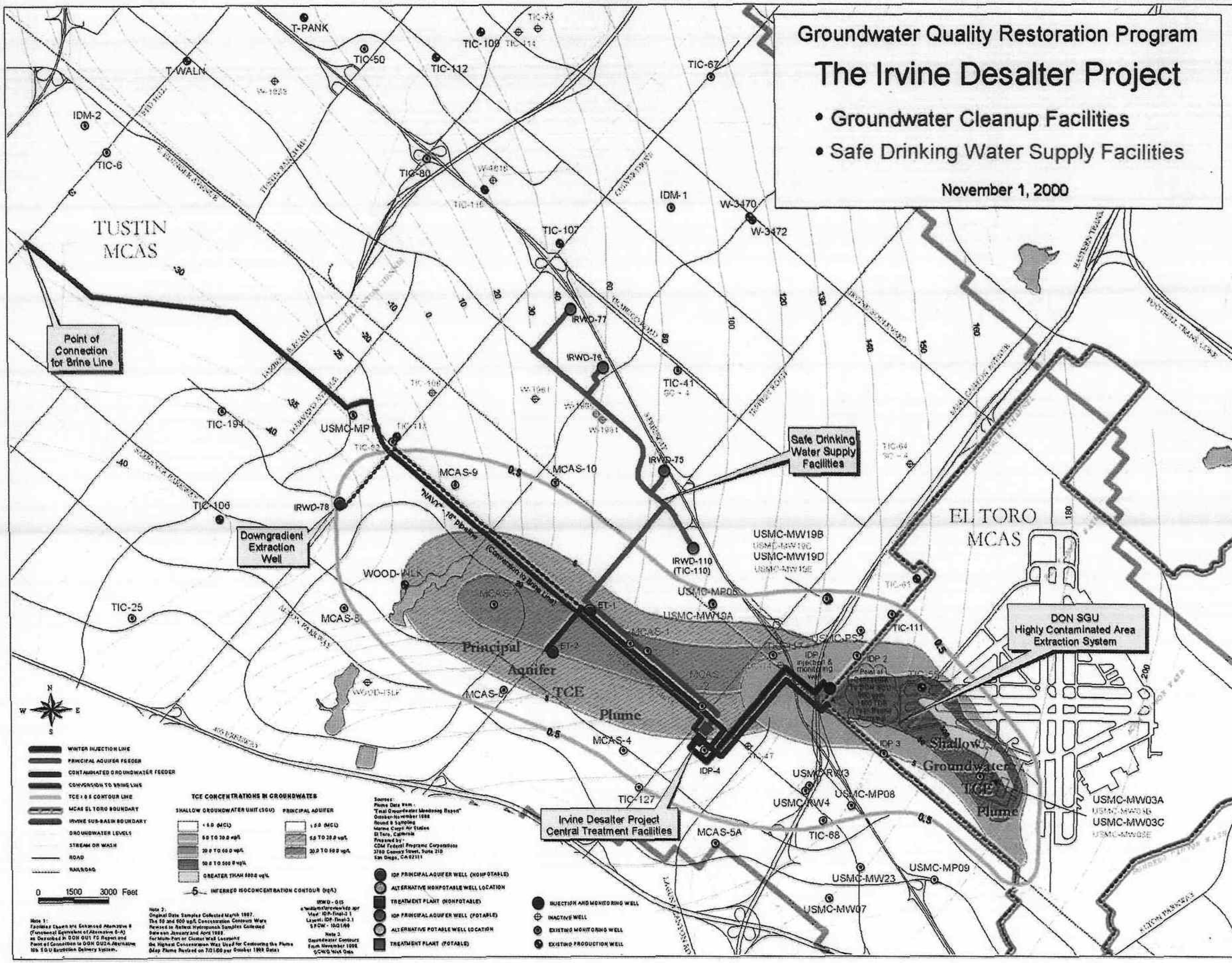
1 Present worth cost is based on 40 years of O&M.
2 Based on a 0 percent share of the dual-purpose components.
3 Based on a 50 percent share of the dual-purpose components.

Simulated TCE Mass Removed After 20 Years

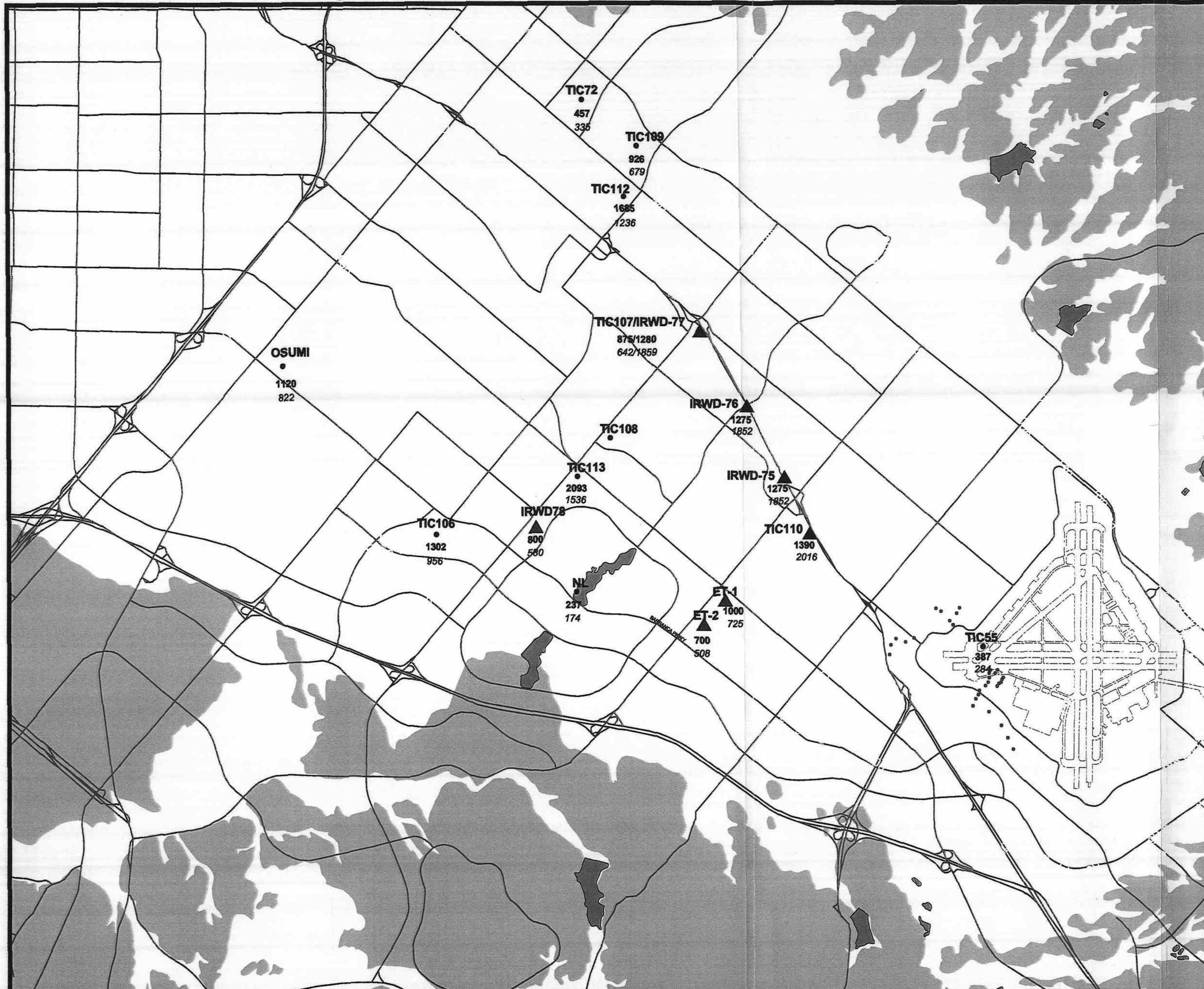
Alternative		TCE Mass Removed (lbs)			Comparison Against No Action	
		By Extraction	By Biodegradation	Total	Additional TCE Mass Removed (lbs)	No. of Times More TCE Mass Removed
1	No Action	580	2,530	3,110	NA	NA
2A	MCAS El Toro Project Without ET-1	10,750	1,790	12,540	9,430	3.0
6A	MCAS El Toro Project and Partial IDP With Discharge to Use Only	12,270	1,480	13,750	10,640	3.4
7A	MCAS El Toro Shallow Groundwater Project	10,040	1,790	11,830	8,720	2.8
7B	MCAS El Toro Shallow Groundwater Project With Contingency Wells	9,950	1,800	11,750	8,640	2.8
8	MCAS El Toro Shallow Groundwater Project and Modified Partial IDP With Discharge to Use Only	11,710	1,490	13,200	10,090	3.2
	IDP Preferred Alternative	12,400	1,600	14,000	10,890	3.5

Note:
NA = Not Applicable

Simulated TCE Plume Areas in the Principal Aquifer After 20 Years		
Alternative		Above-MCL TCE Plume Area (acres)
1	No Action	1,428
2A	MCAS El Toro Project Without ET-1	1,082
6A	MCAS El Toro Project and Partial IDP With Discharge to Use Only	939
7A	MCAS El Toro Shallow Groundwater Project	1,308
7B	MCAS El Toro Shallow Groundwater Project With Principal Aquifer Contingency Wells	1,303
8	MCAS El Toro Shallow Groundwater Project and Modified Partial IDP With Discharge to Use Only	979
	IDP Preferred Alternative	1,073



Groundwater Quality Restoration Program
The Irvine Desalter Project
• Groundwater Cleanup Facilities
• Safe Drinking Water Supply Facilities
November 1, 2000
TUSTIN MCAS
EL TORO MCAS
Point of Connection for Brine Line
Downgradient Extraction Well
Safe Drinking Water Supply Facilities
DON SGU Highly Contaminated Area Extraction System
Irvine Desalter Project Central Treatment Facilities
Principal Aquifer TCE Plume
Shallow Groundwater TCE Plume
"NAVY" 18" Pipeline (Conversion to Brine Line)
T-PANK
T-WALN
TIC-50
TIC-112
TIC-109
TIC-67
IDM-2
TIC-6
TIC-80
IDM-1
W-3470
W-3472
TIC-107
IRWD-77
IRWD-76
TIC-41
TIC-194
USMC-MP1
TIC-106
IRWD-78
MCAS-9
MCAS-10
IRWD-75
IRWD-110 (TIC-110)
USMC-MW19B
USMC-MW19D
WOOD-WLK
TIC-25
MCAS-8
ET-1
ET-2
USMC-MP05
USMC-MW19A
TIC-111
USMC-PS2
IDP 2
IDP 3
IDP-4
MCAS-6
MCAS-4
TIC-127
MCAS-5A
USMC-RW3
USMC-RW4
USMC-MP08
TIC-68
USMC-MW23
USMC-MP09
USMC-MW07
USMC-MW03A
USMC-MW03C
0.5
WINTER INJECTION LINE
PRINCIPAL AQUIFER FEEDER
CONTAMINATED GROUNDWATER FEEDER
CONVERSION TO BRINE LINE
TCE 0.5 CONTOUR LINE
MCAS EL TORO BOUNDARY
IRVINE SUB-BASIN BOUNDARY
GROUNDWATER LEVELS
STREAM OR WASH
ROAD
RAILROAD
TCE CONCENTRATIONS IN GROUNDWATER
SHALLOW GROUNDWATER UNIT (SGU)
PRINCIPAL AQUIFER
GREATER THAN 500.0 ug/L
INFERRED ISOCONCENTRATION CONTOUR (ug/L)
IDP PRINCIPAL AQUIFER WELL (NONPOTABLE)
ALTERNATIVE NONPOTABLE WELL LOCATION
TREATMENT PLANT (NONPOTABLE)
IDP PRINCIPAL AQUIFER WELL (POTABLE)
ALTERNATIVE POTABLE WELL LOCATION
TREATMENT PLANT (POTABLE)
INJECTION AND MONITORING WELL
INACTIVE WELL
EXISTING MONITORING WELL
EXISTING PRODUCTION WELL
0 1500 3000 Feet
N
S
W
E



FEATURES:

- ▲ IDP POTABLE WATER WELL
- ▲ IDP NON-POTABLE WATER WELL
- • EXISTING PRODUCTION WELL
- • SHALLOW EXTRACTION WELL
- MCAS EL TORO BOUNDARY
- LAKE/RESERVOIR
- BEDROCK

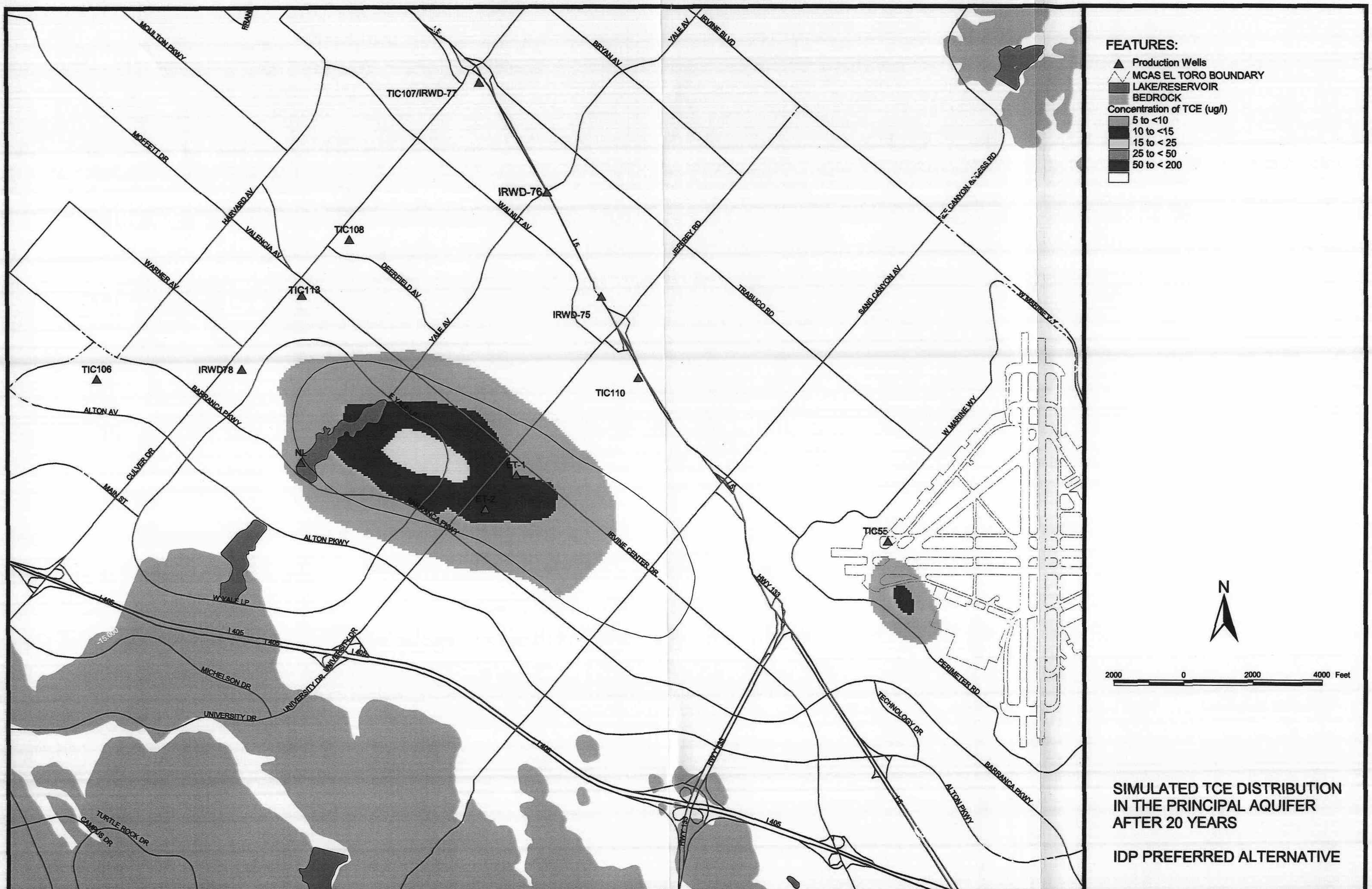
Note: Flowrates are shown in
Gallons per minute - in bold
Acre feet per year - in italics

N

2000 0 2000 4000 6000 Feet

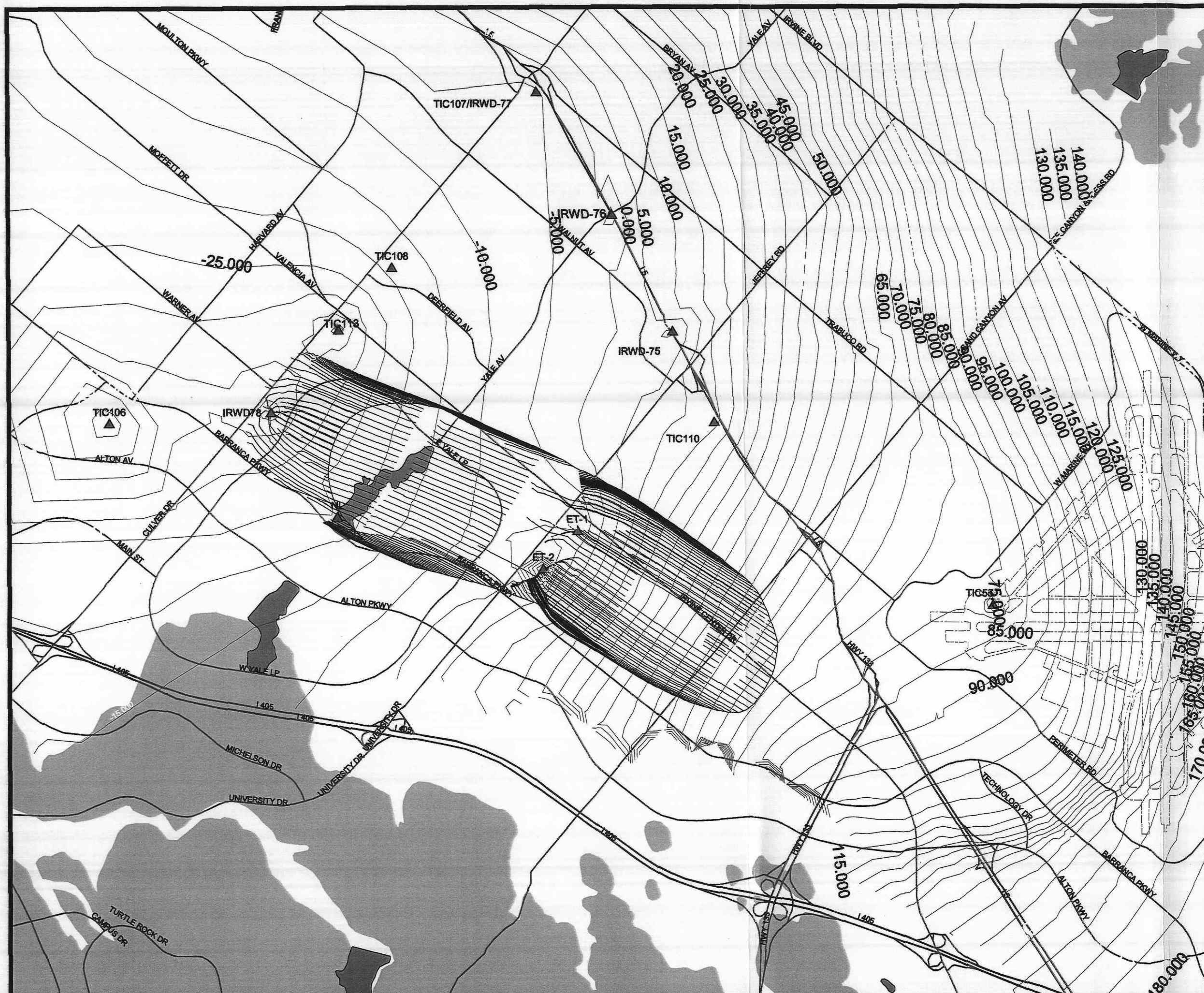
PRODUCTION WELLS

IDP PREFERRED ALTERNATIVE



SIMULATED TCE DISTRIBUTION IN THE PRINCIPAL AQUIFER AFTER 20 YEARS

IDP PREFERRED ALTERNATIVE



FEATURES:

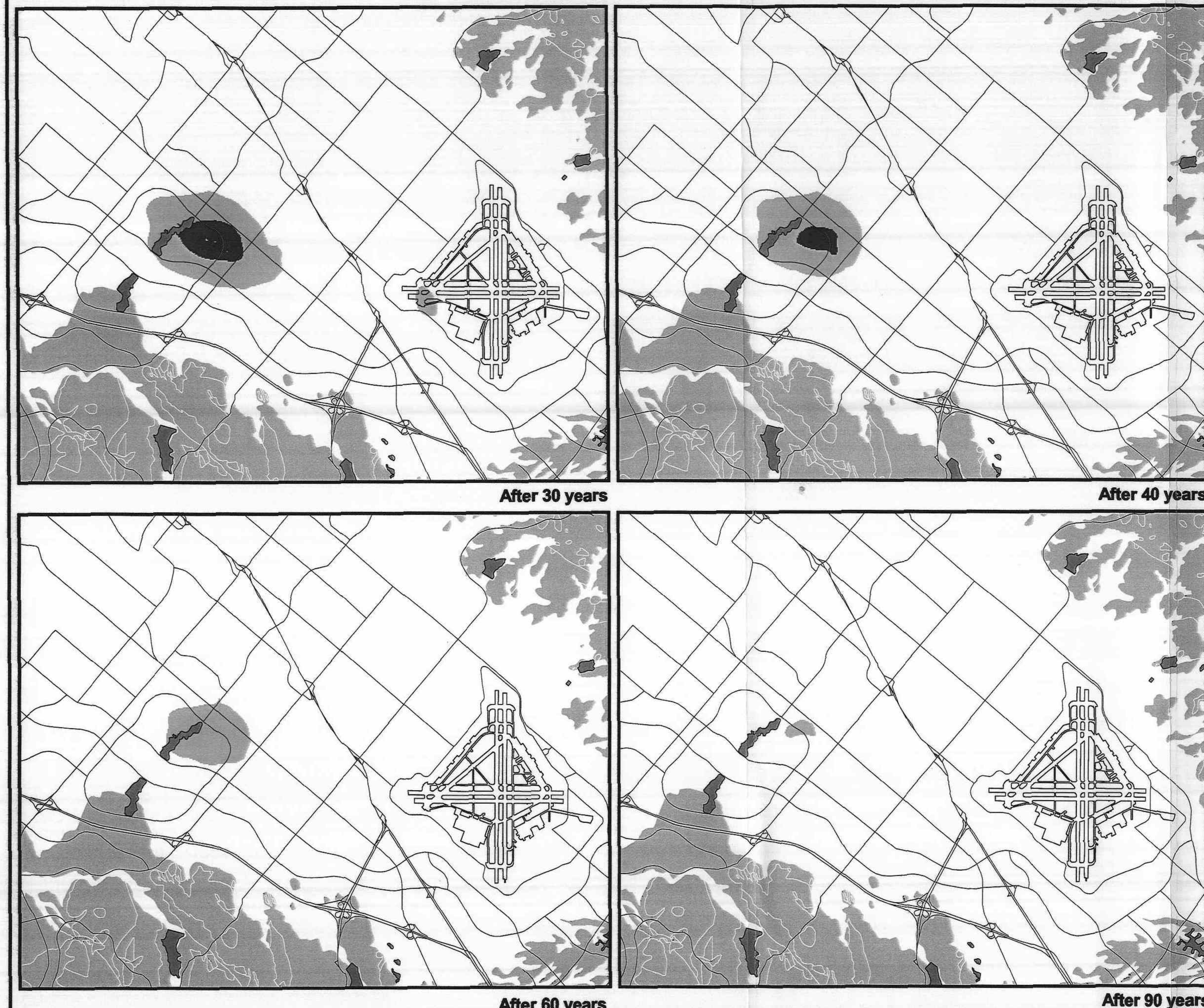
- ▲ Production Wells
- Groundwater Pathlines from TCE Plume
- Water Level Contours (ft msl)
- MCAS EL TORO BOUNDARY
- LAKE/RESERVOIR
- BEDROCK

N

2000 0 2000 4000 Feet

SIMULATED WATER LEVELS
AND GROUNDWATER PATHLINES
FROM THE TCE PLUME IN THE
PRINCIPAL AQUIFER
AFTER 20 YEARS

IDP PREFERRED ALTERNATIVE



N

1 0 1 Miles

LEGEND

Roads
Lake/Reservoir
Bedrock
MCAS El Toro Boundary

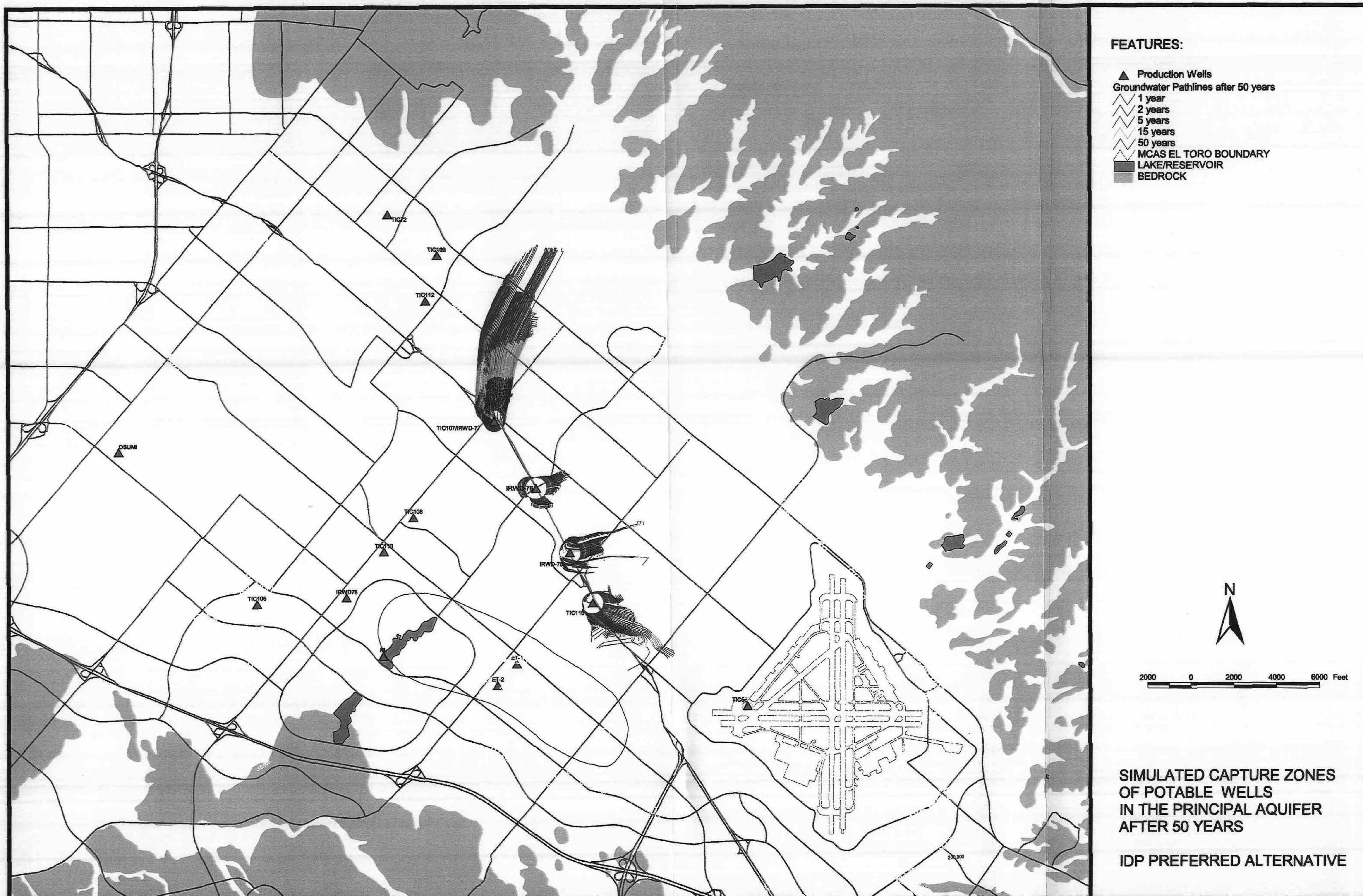
Concentration of TCE (ug/l)

5 to <10
10 to <15
15 to < 25
25 to < 50
50 to < 200

SIMULATED CONCENTRATIONS OF TCE IN THE PRINCIPAL AQUIFER NO-SOURCE SCENARIO

IDP PREFERRED ALTERNATIVE

CH2MHILL



SIMULATED CAPTURE ZONES OF POTABLE WELLS IN THE PRINCIPAL AQUIFER AFTER 50 YEARS